

SCIENCE

VOL. 74

FRIDAY, DECEMBER 4, 1931

No. 1927

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa.

Garrison, N. Y.

Annual Subscription, \$6.00

Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SOME REFLECTIONS CONCERNING VALENCE VARIATION AND ATOMIC STRUCTURE¹

By Professor M. GOMBERG
UNIVERSITY OF MICHIGAN

PERMIT me, please, to offer a word of explanation concerning the choice of the subject for this evening's talk. Many years ago it fell to my lot to become interested in a striking instance of valence variation, and the solution of that problem rested wholly on experimental laboratory evidence. A number of other similar cases of valence variation have been subsequently encountered by various workers, and their conclusions, also, rested on experimental evidence. Meanwhile, during the last ten years, and especially during these last five years, the theoretical aspect of the entire valence question has received much clarification as a result of certain theories based on the spectroscopic study of the elements. The question is alluring—do the empirical findings, in this branch, of the near past harmonize with the recent theoretical deductions? Obviously, the nature of the reply to this question

will be colored to some extent by the psychology of the questioner, but the correctness of the answer can only be in proportion to the requisite technical training possessed by the inquirer. On that last score, I bespeak your generous indulgence.

THE KARLSRUHE CONGRESS

To-morrow, September 3, will mark the seventy-first anniversary since the occurrence of the interesting gathering of chemists, in 1860, in the peaceful little city of Karlsruhe, Baden. The delegates came from all countries in Europe, in response to an invitation sent out by a self-appointed committee. Among the 45 signatures attached to the invitation were those of Liebig, Wöhler, Bunsen, Frankland, Williamson, Pasteur, Dumas, but the moving spirit of the organization was young Kekulé. The object of the meeting was to see if by exchange of opinions some reasonable agreement could be reached in regard to the precise

¹Address of the president, the American Chemical Society, Buffalo, N. Y., September, 1931.

definitions of the concepts atom, molecule, equivalent, atomicity, etc. Not all the original signatories to the invitation came to the meeting. Among the some 130 in attendance, Bunsen was present, with the spectroscopic discovery of caesium only a few months old. Dumas, Stas, Marignac, Friedel, Wurtz were there. Of the much younger men, one may mention Roscoe, Wislizenus, Beilstein, Erlenmeyer, and also young Adolph Baeyer, 25, a privat-docent fledgling and eager for some kind of position.

It was at the last session of the meeting that Cannizzaro urged upon his hearers the adoption of the long neglected, fifty-year old hypothesis of Avogadro as the only safe guide for differentiating between atom and molecule, as the only safe basis for establishing atomic and molecular weights. Within the next few years Cannizzaro's tables of atomic weights were much in use. This proved to be an important factor in the successful development of the valence hypothesis, since the hypothesis depended for its conclusions upon the relation between equivalent and atomic weight.

VALENCE VARIATION

The question, whether a given element possesses a fixed or variable valence, came at once to the front and continued to serve for many years as a perennial topic of bitter disputes. Kekulé, having been so very successful in his development of structural organic chemistry by attributing to carbon an unvariable valence of 4, made up his mind that all other elements must have each some definitely fixed and unalterable valence. Henceforth he remained committed to this point of view, insisting that valence, like the atomic weight, is an unchangeable attribute of an atom. In order to explain away the existence of such compounds as NH_4Cl or PCl_5 , he brought forward his well-known view of molecular compounds. Ammonium chloride, in Kekulé's language, was a combination of the molecule NH_3 and the molecule HCl , held together not in virtue of an increase in the valence capacity on the nitrogen atom from 3 to 5, but in virtue of some kind of attraction between the two molecules. This notion of molecular, in distinction from true atomic, combination has been handed down from generation to generation with such slight modifications of meaning as are implied in the terms molecular complex, residual affinity, auxiliary valence, coordination number, etc.

After all, the question of valence variation for one and the same element was but a part of a much deeper mystery. Why do the *various* elements differ among themselves in combining capacity? How far can this difference extend? A partial answer to this query was supplied by the revelation that all properties of the elements, including that of valence, appear to be periodic functions of the atomic weights, repeating

themselves after each little group of seven or eight elements, if the elements be arranged in the order of their atomic weights. Biographers like to trace the inception of the Periodic Table, directly or indirectly, to the Karlsruhe meeting in 1860. Be that as it may, both L. Meyer and young Mendeleeff were present at that gathering and both became ardent disciples of Cannizzaro's reforms. It may not be without interest to mention that in his first paper (1869) Mendeleeff did not include valence as a periodically recurring property of the elements, but a year later, in his second and more complete paper, valence appears as the most important periodic function, being successively 1 to 7 for the seven groups, or 1 to 8 if we include also the iron-cobalt group. And ever since, valence has retained its importance in the periodic classification of elements.

Mendeleeff was aware that he could make valence a strictly periodic property, provided the oxygen derivatives of the elements are considered and not their hydrogen derivatives. In the third period, for instance, we have a clear-cut procession of valence from one to that of seven: Na_2O , MgO , Al_2O_3 , SiO_2 , P_2O_5 , SO_3 and Cl_2O_7 . If the valence of these same elements be measured by their hydrogen derivatives—the picture changes. The first three vertical groups in the periodic table give no stable hydrides, the fourth group indicates, again, quadrivalence, but groups V, VI and VII indicate a successively decreasing instead of increasing valence, namely, 3, 2 and 1, as for instance in PH_3 , SH_2 , ClH . Thus the periodic table in a way confirmed the contention of the earlier chemists that valence of elements can not be considered as fixed, for it seems to vary with the nature of the measuring element, whether the latter be oxygen or hydrogen. Moreover, some of the elements, even in group IV, were known not to be exempt from valence variation towards one and the same element—i.e., titanium forming compounds TiCl_2 , TiCl_3 and TiCl_4 ; tin and lead being di- as well as tetra-valent.

DEFICIENCY VALENCE

Gradually it became tacitly recognized that as a rule the elements do conform to their group position in the periodic table as regards their maximum valence; and then it was further assumed that some elements do not always exercise the full limit of their valence capacity, this being especially the case with the non-metals. The hunt for the possible occurrence of deficiency-valence became a frequent subject for experimentation, and this search extended well into the present century. Thus, the claim has been made repeatedly that sub-oxides with anomalously low valence result when the oxalates of certain metals are heated at 200–300° C. Moissan, in 1899, mentions that

metallic calcium reduces calcium di-iodide to calcium monoiodide on fusing together the mixture of the di-iodide and the metal. Haber found that barium monochloride resulted from the electrolysis of barium dichloride at 500–600° C. Calcium monochloride has been prepared crystalline, and in remarkably pure state, by heating in small bombs the dichloride with metallic calcium to 1,000° and then plunging the bomb into solid CO₂.

Carbon, more so than any other element, seemed to possess a fixed valence, tens of thousands of carbon compounds, with carbon functioning always as quadrivalent, offering testimony to that effect. When, therefore, it was demonstrated that carbon, also, may on occasions exhibit a deficiency of one valence and function as trivalent, it opened a wide field for search of anomalous valence behavior on the part of other elements. As a result, we now know of the existence of compounds which may contain in their molecules either monovalent oxygen, or divalent nitrogen, trivalent lead or tin, monovalent iron, cobalt, nickel or manganese.

EXCESS VALENCE

To say that deficiency valence results from non-operativeness of the maximum possible potential valence does not of course explain the phenomenon, but at least it makes it not irreconcilable with the postulates of the periodic system. The case, however, is different when we come to consider that large class of complex compounds which result from combination of several whole and completely saturated molecules. Take the very simple example, K[Ag(CN)₂]. When dissolved in water, dissociation occurs and there are formed the ions K⁺ and [Ag(CN)₂].—Evidently, the atom of silver in the anion is functioning as if it were divalent. Similarly, in K₂(HgI₄), Hg is apparently quadrivalent; in K₄Fe(CN)₆ the atom iron is hexavalent. In order to obviate, or at least to soften, this discrepancy between valence as ordinarily understood and the peculiarly high valence of the elements in these complex substances, Werner called the latter kind of valence "coordination number."

Obviously, for an adequate explanation of both aspects of valence variation, deficiency and excess, there is required something more than merely the knowledge of the quantitative manifestation of the valence action. A knowledge of the nature of the causative agent of valence, and of the mechanism involved in the action of that agent, are essential. The disclosures of atomic structure are gradually supplying the knowledge of these two factors.

ATOMIC STRUCTURE

Mendeleeff survived by almost ten years the establishment of the doctrine that the electron is a constituent common to all elements. It would be interest-

ing to learn what was Mendeleeff's reaction to this epochal discovery of Thomson's, since Mendeleeff himself had repeatedly insisted that "the periodic law affords no indication of the unity of matter or of the compound character of the elements." What a striking change in our cosmic views in so short a period! That all matter is electric in its nature is now a fundamental tenet in modern science.

The Rutherford-Bohr planetary atom, with its positively charged nucleus surrounded by the negatively charged electrons, has reached, as you know, that astounding stage of development when one may speak of the structure of the atom with a reasonable degree of confidence. Still, for one whose detailed knowledge of the subject is not of that extent when familiarity with the subject shields one against surprises, for such a person there is something terrifying in the boldness of the statement, however well founded it may be, that a single atom of mercury consists of 400 individual units, and that its 200 electrons can be arranged into at least 15 groups in accordance with their respective specific functions in the atom in its normal state. Still more astounding is the statement that in a single atom two electrons can never coincide in all their energy relations to the atom.

This is not the occasion to undertake a detailed account of the theories of atomic structure, and I am certainly not the person qualified to undertake the task. In presenting the following few remarks I shall endeavor to observe Mr. Sidgwick's sound advice to the chemist—"not to use the terminology of physics unless he is prepared to recognize its laws."

Basing their deductions upon the study of the manifold series of lines in the optical and the x-ray emission spectra of the elements, and in order to account for these series, the spectroscopists have concluded that the electrons which surround the nucleus can be classed into several principal groups in accordance with their respective energy content. We can imagine, with Bohr, that as the number of the planetary electrons, in the heavier atoms, becomes larger, they arrange themselves in concentric shells around the nucleus, each shell being characterized by its own energy level. The first horizontal series, hydrogen to helium, has one shell, and each succeeding series—whether the series be long or short—acquires an additional shell.

VALENCE ELECTRONS AND VALENCE ACTION

Much detailed knowledge is at hand concerning the exact number and disposition of the electrons in the individual inner shells. The chemist, however, is interested mainly in the outermost electrons, for these alone are affected in chemical reactions between atoms. The elements in the first vertical group of the Mendeleeff-Moseley periodic table are monovalent and con-

tain each one valence electron; the divalent elements in the second group contain 2 such electrons, etc. The inert gases in the eighth group are zero-valent, and are supposed to owe their stability and inertness to the presence of 8 electrons in exterior shell. It is one of the unsolved mysteries—or one of the arbitrary postulates, as you wish—that an exterior shell, no matter how many other shells happen to interpose between it and the nucleus, becomes stabilized by the presence of 8 electrons, while shells three and four, counting from the nucleus, may contain, and for full stabilization actually require, 18 and 32 electrons, respectively. The great acumen with which G. N. Lewis and also I. Langmuir, two pioneers in this field, have expounded this theory of a stable 8-electron shell, and also the application of this theory to molecular structure, is recent history to all of us.

It is customary to distinguish three kinds of valence action: (1) When each of the two combining atoms contributes a valence electron and the bond consists in the two atoms sharing the pair of electrons. This conception is almost identical with the original notion of the bond as has been used in organic chemistry since the days of Kekulé, except that the idea is now put in modern nomenclature. Such a bond is said to be non-polar or co-valent. (2) An atom may be completely robbed of one of its valence electrons, and so becomes a positively charged ion; (we may call this a positive valence). (3) The atom may gain an electron from some other atom, and become a negatively charged ion; (this we may designate as a negative valence). The last two modes of valence action are generally grouped together as electro-valence, since they both result in the establishment of a polar bond, *i.e.*, the two oppositely charged ions being held in loose combination through electrostatic attraction. However, for the purposes of the present discussion it seems preferable to class all three modes of valence operation into one group, *i.e.*, the so-called electro-valence bond involves also the participation of a valence electron from each of the atoms that are held by the electro-static attraction. A word of explanation seems necessary. For some time I have been a slave to the idea that an electro-valence bond is a secondary, and never a primary result of valence action. The primary phase consists always in the establishment of a pair of shared electrons between two atoms, one electron from each participating atom. Whether the bond remains as so formed, or whether the pair of electrons will shift wholly to one of these two atoms—impoverishing the one and enriching the second atom by one electron—is a matter which depends upon the relative sizes of the nuclei of the two atoms, and upon many other circumstances. For instance, hydrogen chloride, liquefied, is not an electrolyte, and hence the bond is non-polar; but when dis-

solved in water, the bond becomes polar and dissociation is almost complete. Many analogous instances may be cited—and one is not wholly unjustified in making the generalization that all bonds are, in their primary phase, non-polar, requiring from each of the two atoms one electron, the two electrons being “corresponding electrons (London, Heitler). The remarks which follow refer therefore to the non-polar, as well as to the primary phase of the electro-valent bond.

DISTRIBUTION OF VALENCE ELECTRONS

Now, there is abundant spectroscopic evidence that the valence electrons are not limited exclusively to the very outermost shell alone. This is particularly true of the elements with atomic weight of 45 and above, and the atoms of which have more than 3 shells. There are almost 20 elements, the valence electrons of which must be considered as distributed, part being in the outer shell and some in the next underlying shell. Moreover, in some rare earths, the distribution of the valence electrons occurs into 3 shells. It stands to reason that elements of this kind must exhibit variable valence. In some chemical reactions the electrons in the outer shell alone may be induced into action, while under other different circumstances valence electrons in the underlying shell as well may become detachable, and thus may also become operative as valence electrons. Such elements are Se, Ti, Cr, Mn, etc. These elements are well known for their multiple valence.

However, even in those elements where the valence electrons are all contained in the outermost shell only, occurrence of variable valence is still consistent with atomic structure theories. Spectroscopic evidence indicates that the electrons in the outer shell, on the basis of their energy content, fall into two subgroups, 2 electrons in the first subgroup, and the remaining, from 1 to 6, as the case may be, fall into the second subgroup. It is conceivable that, beginning with the third vertical group, where the elements have each three valence electrons, either all three valence electrons in the atom may become operative, or only those that belong to one of the two subgroups, according to particular conditions of chemical reaction. The finding of the still unknown AlCl or AlCl_2 , in addition to the well-known compound AlCl_3 , should occasion no great surprise, since the three valence electrons in aluminium are not all in the same subgroup. Indeed, beginning with the fourth vertical group in the periodic table, such variation is known to be rather the rule than the exception, and this behavior is quite in agreement with the postulate of the theory, since the valence electrons, although all in the exterior shell, are distributed among two sub-classes as 2.2, 2.3, 2.4, 2.5, in IV, V, VI, VII periodic groups respectively. Thus, we have PbCl_2 as well as PbCl_4 ; PCl_3 , PCl_5 ; SCl_2 , SCl_4 , SF_6 , etc. Of course, not all permissible

variations in molecular composition have as yet been realized. For some of these compounds, at the present time still hypothetical, theoretical considerations predict an endothermal and unstable state; other compounds, even if predicted to be thermodynamically stable, are likely to prove less stable than analogous products into which they can readily transform. Thus, AlCl is probably an exothermic compound and should exist, were it not for the fact that AlCl_3 is decidedly more stable; consequently, there is a tendency for the following reaction to occur spontaneously: $3 \text{AlCl} = 2 \text{Al} + \text{AlCl}_3$.

Thus, the manifestation of valence variation appears explainable in the case of such atoms which have their valence electrons distributed among 2 or 3 shells; explainable also in the case of atoms the valence electrons of which are all located in one shell, but the number of these electrons is more than 2. But how do the following instances of valence variation find their explanation: (1) In the second group metals—Mg, Ca, Sr, etc.—the two valence electrons are both in the same shell and both belong to the same subgroup; therefore, both electrons may be expected to enter into the formation of a bond with equal ease and therefore simultaneously. And yet we know, as cited in the early part of the paper, under certain conditions this is not the case. (2) Carbon, with its 4 electrons as 2,2, may be expected to function as bivalent and quadrivalent—but why trivalent? Similarly, why oxygen-univalent? (3) Why in chlorine, is valence variation by two—1, 3, 5, 7? How to explain the fact that fluorine, a member of the same group with chlorine, is always univalent, and no more?

You would not wish me to enter here upon the discussion of these and other similar questions. May I merely say that, in my judgment, no one can fail to be impressed by the cogency of the arguments which London, Heitler and others have built up during the last three or four years, on the basis of what is known as Pauli's Exclusion Principle. All the above-mentioned valence variations seem to be explainable in a satisfactory manner.

The above few illustrations may suffice to show that modern atomic structure theories are of great assis-

tance to the chemist in explaining valence variation. What used to be a purely empirical fact becomes in the light of these theories an understandable concrete process. The occurrence of compounds with monovalent calcium or magnesium, divalent aluminum, trivalent carbon, and other cases of deficiency valence are not only compatible with these modern theories, but are predictable on the basis of the theories. The situation is not quite so satisfactory when we come to consider the coordination compounds, wherein elements exhibit what looks like excess valence. Nearly all attempts at explanation of these cases of valence variation make wide use of hypotheses, which in themselves may be legitimate and are plausible, but they do not rest on sufficiently clear-cut experimental evidence. It is not surprising, therefore, that two such eminent authorities as Sidgwick and Sugden do not agree whether a non-polar bond always requires for sharing a pair of electrons or whether a single electron will suffice; whether an octet of electrons around an atom is the limit, or whether ten, twelve and more electrons are also possible. The fundamental theory, however, of atomic structure is sound, and we may rest assured that these problems will in time also be solved.

CONCLUSION

In bringing to a conclusion these few scattered reflections concerning valence variation and atomic structure, may I be permitted to say this: He who is experimentally inclined may henceforth take heart and he need not be quite so timid in interpreting strange chemical reactions on the assumption of possible anomaly in the valence of the reactants. The physicist has no hesitation in speaking of the temporary existence, at the higher temperature employed in spectroscopic work, of such molecules as BaCl , AlO , (HO) , CH^+ , CH_2 , MgF , etc. Is it not possible that under the influence of surface forces somewhat similar valence variation may not be excluded even at lower temperatures? That these strange compounds are thermodynamically unstable may be true. Nevertheless, they may function as the mysterious catalysts, or as initiators of chain reactions.

NEW CONCEPT OF EVOLUTION BASED UPON RESEARCHES ON THE TITANOTHERES AND THE PROBOSCIDEANS¹

By Dr. HENRY FAIRFIELD OSBORN

PRESIDENT OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE new concept of evolution is not to be confused for a moment with the pre-observational "entelechy"

of Aristotle, the "vitalism" of Driesch, the "évolution créatrice" of Bergson, the "emergence" of Lloyd-Morgan, the "holism" of Smuts, or any other of the age-long "internal-perfecting" hypotheses which are

¹This is the seventh paper on the Origin of Species, and the newer aspects of the Evolution problem. The National Academy of Sciences, November 16, 1931.

more or less metaphysical anticipations of the order of nature. It is, on the contrary, purely inductive or post-observational.

The new concept is based on thousands if not hundreds of thousands of observations on invertebrate and vertebrate fossils. The mammals for the first time reveal the complete life history of a great hoofed family, the Titanotheres, during twelve million years, of a great hoofed order, the Proboscideans, during thirty million years, gathered from all the museums and all the countries of the world. The anatomical contrasts between these two groups of animals, namely, the arrest of tooth evolution in one and the marvelous progress of tooth evolution in the other, serve to absolutely establish the nine new principles of paleontology revealed since 1869.²

Recently the grinding teeth of the Proboscideans enable us for the first time to establish the rate of evolution in an extremely important adaptive organ, very slow even in the course of ten thousand years. This incredibly slow rate exposes the futility of modern experimental research which would produce a new character in a single year or in a few seconds.

In brief, the new concept of evolution is forced upon us by the discovery since the year 1869 of nine new principles of biomechanical evolution which were not only unknown to Charles Darwin but are antagonistic to one of his fundamental theses that Nature does anything by variation, by fortuity, by accident or by chance. It has taken sixty-two years of observation, namely since Waagen's observation of 1869, to demonstrate that organic like inorganic Nature does nothing by accident or by chance but only by means of universally prevailing adaptive principles which are only revealed in long secular periods of time. The very words adaptive action, reaction and interaction imply a chasm between biomechanism and inorganic mechanism, across which there is no bridge at present.

Moreover, as the principal point of the present address, we are compelled to return to a creational concept of evolution. Mark that the word *creational* is used without any of its old theological or philosophical implications; it is clearly distinct from the word *created*; there is no equivalent in the Greek language. For this concept the term "aristogenesis" is provisionally suggested until the classicists can furnish us with a single term signifying the *creative origin of the adaptive*.

A brief survey of the twenty-five centuries of observation and induction brings us face to face with this new concept.

² These nine principles are set forth in the British Association Centenary Address, September 25, 1931, to be printed in *The American Naturalist*, January-February, 1932.

DARWIN THE FOUNDER OF PALEONTOLOGY

After its brilliant inception by Cuvier at the close of the 18th century, paleontology lapsed during the first half of the 19th century into a merely descriptive and systematic science on the Continent and even in Britain under the genius of Hugh Falconer and Richard Owen. Despite great discoveries in India, Australia, South America and Europe, paleontology lacked any central principle; its philosophical potentialities were never released. Falconer and Leidy, who opened up the ancient fauna of the Siwaliks of India and of western America and who recognized ancestral affinities in the Proboscideans, horses and other mammals, spoke guardedly of descent because there was a hush on the old concept of evolution. It was Darwin, the disciple of Lyell and the observer of South American Pampean fossils, who reanimated this slumbering giant of Biology, and created modern paleontology, which reveals the life history of the earth's billion years, and furnishes the only absolutely incontrovertible proof for Darwin's "Origin of Species" and "Descent of Man."

Darwin worked altogether on the old variational concept; he lived too soon to see the fruits of the evolutionary paleontology, which he founded. Not a single *phylum* or actual line of descent, not an ascending or descending mutation, not a single specific origin, not a single character origin was known to Darwin. In invertebrate lines of descent Waagen (1869) led the way to the new concept of evolution closely followed by Neumayr, and Alpheus Hyatt. Among the vertebrates, Leidy, Cope, Marsh, Gaudry were the pathfinders of phylogeny and of continuous lines of ascent. But the pioneer in the Darwinian revolution was Waldemar Kowalevsky, the first to apply Darwin's survival of the fittest idea to single adaptive or inadaptive organs.

Among the *older hypotheses as to the modes of evolution or organs* paleontology proves that Lamarck was wrong in his main assumption that characters acquired by the soma are inherited; Darwin was wrong in adding Lamarckism to his original selection theory. Paleontology also reveals the fallacy in McBride's recent Lamarckian argument that habit is a driving factor in evolution; habit is not the driving factor but it is one of the guiding factors; grant the whole arguments of the Lamarckians, ancient and modern, the larger part of biomechanical evolution would still remain unaccounted for. Darwin knew not a single one of the nine paleontologic principles discovered since his time. DeVries was wrong in believing that species arise by the selection of fortuitous mutations. Darwin passed away just at the time when Weismann was establishing his cellular continuity of the germ-plasm principle; Weismann was

wrong in his subsidiary super-selection assumption that fortuitous variations of the germ-plasm give rise to new species. Darwin recognized the sub-species of birds and tortoises on the Galapagos Islands produced by geographic isolation, but he lived too soon to recognize Wagner's now well established principle of the origin of species and sub-species through geographic isolation. Darwin was doubtful of Buffon's factor of speciation through the direct action of environment; he was astonished at the pioneer case of *Saturnia* brought forward by Wagner. Darwin knew not a single case of intergradations between living species; we now know hundreds of intergradations in fishes, birds, reptiles and mammals.

As to the older hypotheses as to the origin of single characters, throughout Darwin's life period our attention was mainly concentrated on species rather than on single characters. In this after-period both zoologists and paleontologists are concentrating on the origin of single characters of which sub-species, species, genera and orders are by-products. Understand the origin, rise and fall of a single adaptive biomechanical character and you will understand the whole story. It is like Tennyson's "flower in the crannied wall."

In conversation with Dr. Hans Spemann recently, and knowing of his brilliant researches upon "living organizers," I asked him to produce a system of fossil organizers by which the nine new principles revealed by paleontology could be coordinated. He declared himself an agnostic as to the causes of evolution. I also am a complete agnostic, perhaps even more of an agnostic than Spemann, because, while he may be familiar with the eleven principles of biomechanical evolution revealed by zoology and comparative anatomy, we have through forty years of continuous observation become familiar with nine additional principles revealed by paleontology.

It does not detract one iota from Darwin's greatness as the founder of modern paleontology to say that it revolutionizes Darwin's old variational concept of the evolution process, even as Cuvier's paleontology of special-creation and successive-creation concepts was revolutionized by Darwin. Would that Darwin could return to earth to see his fossil offspring and to welcome the new concepts revealed in the extinct animal and plant kingdoms and of man.

SIX PRINCIPLES OF THE NEW CONCEPT

Certain of these six principles of biomechanical evolution were presented in the author's Hale Lectures before the National Academy in the year 1916, subsequently published in a volume entitled "The Origin

and Evolution of Life." Others are here stated for the first time.

(1) *Uniformitarian rather than cataclysmal.*

Organic evolution conforms with the uniformitarian interpretations of Hutton and Lyell of the middle of the 18th century which had such a profound influence on the mind of Darwin. The uniformity of organic evolution proceeds with the uniformity of the physical and chemical environment.

(2) *Centrifugal rather than centripetal.*

Paleontology strengthens Weismann's epoch-making generalization of 1880, namely of the geneplasmic rather than somatic origin of all characters. No characters arise except from latent potentialities in the germ.

(3) *Creational rather than variational.*

Paleontology adds something far more important, namely, the adaptive origins of new characters from the germ for which the only term in our language at present is "creational." Paleontology strengthens the conclusions independently reached by zoologists that Darwin, from lack of evidence in his time, overstressed the principle of variation. Paleontology, moreover, demonstrates that variation of *kind* is temporary and fugitive, although plus and minus variation of *degree* is very important under selection.

(4) *Reactional rather than entelechistic.*

This creational process is, however, not wholly spontaneous, independent or emergent except perhaps in the evolution of the mind. The latent biomechanical powers of the germ are only evoked in the process of adaptive reaction either in the course of individual development or as a secular or age-long process.

(5) *Anti-energistic rather than syn-energistic.*

Life tends to borrow energy in order to resist energy—this is the distinctive feature of all living mechanisms—the root of the idea of the struggle for existence.

(6) *Evolution is prot-empirical rather than meta-empirical.*

Many of the biomechanical organs evolve in the geneplasm before there is any actual need for them rather than after the need for them arises. This is in opposition to the main thesis of Lamarck and of Herbert Spencer. Spencer believed that mind was built up through experience, but observed facts prove otherwise. We have found that much larger intelligence exists among primitive people than there is any actual need for, intelligence capable of grasping mathematical concepts among Eskimos who had no need even to count on their fingers.

SCIENTIFIC EVENTS

GRANTS FROM THE ELIZABETH THOMPSON SCIENCE FUND

PREVIOUS awards from the Elizabeth Thompson Science Fund were reported in SCIENCE on November 15, 1929, and earlier. Since the last report the following awards have been made:

At the meeting of December 3, 1929

Margaret Harwood, Maria Mitchell Observatory, Nantucket, \$300 for assistance in the measurement of the light of variable stars and the computation of the periods of variation.

At the meeting of February 11, 1930

R. A. Brink, University of Wisconsin, \$300 for assistance in the classification of pedigreed maize cultures segregating for a condition known as semi-sterility.

J. E. Hull, Belford Vicarage, Northumberland, \$150 for the purchase of a microscope to aid in his studies of the acarina.

Arthur Jacot, Shantung Christian University, \$120 toward aid in carrying on researches on moss mite fauna and on mullets.

R. L. Taylor, Bar Harbor, Maine, \$100 toward the compilation of an alphabetical list and bibliography of the parasitic hymenoptera.

W. S. Cooper, University of Minnesota, \$350 for aid in physiographic and vegetational investigation of the early post-glacial sand dunes of the Mississippi Valley in Minnesota.

L. O. Overholts, Pennsylvania State College, \$150 for assistance in completing a monograph on the poraceae of the United States and Canada.

H. C. Heath, Woman's College of Alabama, \$300 for aid in experiments in the use of potash shale as a soil builder.

At the meeting of November 24, 1930

H. J. Deuel, Jr., University of Southern California, \$300 for investigations on the antiketogenic value of various carbohydrates.

Arthur Jacot, Shantung Christian University, \$200 for aid in duplicating two early collections (now lost) of moss mites.

F. W. Emerson, New Mexico Normal University, \$50 for equipment to study the distribution and means of propagation of the scrub oak and conifer association.

At the meeting of February 28, 1931

William Rowan, University of Alberta, \$400 toward the expenses of his experiments on migratory habits of birds.

At the meeting of May 26, 1931

Gerhard Kirsch and Friedrich Hecht, of Vienna, \$250 to procure a microbalance for special analysis of radioactive minerals with reference to the better determination of the age of the earth.

P. B. Babkin, McGill University, \$300 for assistance

in experimental investigations on the relation of the gastric secretion to pernicious anemia.

At the meeting of November 24, 1931

W. H. Horr, University of Kansas, \$100 for the purchase of certain sugars for the further study of the nutrition of fungi.

The trustees of the Elizabeth Thompson Science Fund meet ordinarily during the last ten days of the months of February, May and November. Applications for grants should be sent well in advance of the meeting to the secretary of the fund, Dr. Edwin B. Wilson, 55 Van Dyke St., Boston, Mass.

THE UNITED STATES PHARMACOPOEIA

E. FULLERTON COOK, Ph.M., Philadelphia, Pa., is chairman of the Committee of Revision of the Pharmacopoeia of the United States of America, 1930-1940.

The chairmen of the sub-committees working on the eleventh revision of the Pharmacopoeia are as follows:

Reid Hunt, M.D., of Boston, Mass., Sub-Committee on Scope.

H. A. Christian, M.D., of Boston, Mass., Sub-Committee on Therapeutics and Pharmacodynamics.

C. W. Edmunds, M.D., of Ann Arbor, Mich., Sub-Committee on Biological Assays.

G. W. McCoy, M.D., of Washington, D. C., Sub-Committee on Biological Products and Diagnostical Tests.

E. L. Newcomb, Ph.M., of New York City, Sub-Committee on Botany and Pharmacognosy.

C. B. Jordan, M.S., of West Lafayette, Indiana, Sub-Committee on Proximate Assays.

John C. Krantz, Jr., Ph.D., of Baltimore, Md., Sub-Committee on Inorganic Chemicals.

G. D. Beal, Ph.D., of Pittsburgh, Pa., Sub-Committee on Organic Chemicals.

Ernest Little, Ph.D., of Newark, N. J., Sub-Committee on Reagents and Test Solutions.

Charles H. LaWall, Sc.D., of Philadelphia, Pa., Sub-Committee on Volatile Oils.

W. L. Seoville, Sc.D., of Detroit, Mich., Sub-Committee on Extracts, Fluidextracts and Tinctures.

H. A. Langenhan, Ph.D., of Seattle, Wash., Sub-Committee on Waters, Solutions, Spirits, Syrups, Elixirs.

Leonard A. Seltzer, Sc.D., of Detroit, Mich., Sub-Committee on Cerates, Ointments and Miscellaneous Galenicals.

Theodore J. Bradley, Ph.D., of Boston, Mass., Sub-Committee on Tables, Weights and Measures.

A. G. DuMez, Ph.D., of Baltimore, Md., Sub-Committee on Nomenclature.

SIGMA PI SIGMA CONVENTION

THE national convention of Sigma Pi Sigma, honorary physics fraternity, was held at the University

of Kentucky from November 5 to 7. National officers, delegates from the twenty chapters and alumni members gathered at 7:30 P. M. on November 5 at the Lafayette Hotel in Lexington for a model initiation of pledges from the Kentucky chapter, the pre-convention smoker and a meeting of the executive council of the society. Formal sessions of the convention began at 9:00 A. M. on November 6, with an address of welcome by Professor Wm. S. Webb, head of the department of physics of the University of Kentucky. Dr. R. C. Young, of the College of William and Mary, then delivered his address as retiring president on "Recent Advances in Physics in their Relations to Other Sciences."

The report of the secretary, Dr. Marsh W. White, of the Pennsylvania State College, indicated a substantial development of interest in the idea of a national honorary physics fraternity, as evidenced by the chartering of fourteen new chapters since the previous convention in 1928 and a growth in membership to more than 700. Among the new chapters scheduled for installation is one at the University of the Philippines. The secretary reported the beginning in 1930 of the publication of a magazine, *The Radiations of Sigma Pi Sigma* and an esoteric publication, *The Bulletin*. Each chapter delegate also presented a report of the activities of his group, showing that open meetings of the chapters during 1930-31 have been addressed by such speakers as R. A. Millikan, K. T. Compton, W. E. Forsythe, Arthur Haas (University of Vienna), D. C. Miller, F. K. Richtmyer, C. E. Mendenhall, etc.

The guest speaker at the convention was Dr. W. F. G. Swann, director of the Bartol Research Foundation. He was initiated into the fraternity as an honorary member, after which he spoke on "Electrodynamics and Relativity." His evening address to a large audience was on "Some Philosophical Concepts of Modern Physics."

At the business sessions on November 7 plans were devised for nation-wide tours of prominent physicists as speakers to the chapters of the fraternity and at neighboring institutions. Officers elected were: *President*, Dr. M. N. States, Central Scientific Company; *Vice-president*, Professor G. D. Collins, Duke University, and *Executive Secretary*, Dr. Marsh W. White, the Pennsylvania State College. The additional members of the *Executive Council* are: Dr. R. C. Young, College of William and Mary; Dr. R. C. Colwell, West Virginia University; R. W. Graves, Duke University, and Dr. J. M. Douglas, Davidson College.

THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS

The second annual meeting of the American Association of Physics Teachers will be held on Decem-

ber 30 and 31 in New Orleans in conjunction with the annual meeting of the American Association for the Advancement of Science, with which this association is affiliated. Headquarters has been established at the Hotel Roosevelt.

On Wednesday, December 30, at 6:30 P. M., the association will meet with the American Physical Society at a joint dinner at the Hotel Roosevelt.

On Thursday, December 31, at 10:00 A. M., the association will meet in Room E, Hotel Roosevelt, and the program will consist of a list of invited papers dealing with various phases of the most recent developments in the teaching of physics.

The afternoon program at 2:00 P. M. will consist of a number of short papers given by members of the association, dealing with special pieces of laboratory and demonstration apparatus of recent development by the authors. Some of this new apparatus and others not discussed in these papers will be on exhibition in the general apparatus exhibit of the American Association for the Advancement of Science in the Municipal Auditorium.

At 4:00 P. M. on Thursday, December 31, there will be the annual meeting for election of officers and transaction of business.

The detailed program of the various sessions may be obtained previous to the meeting by writing to the secretary of the association, Professor Wm. S. Webb, University of Kentucky, Lexington, Kentucky.

THE ANNUAL MEETING OF THE AMERICAN ORNITHOLOGISTS' UNION

The Forty-ninth Stated Meeting of the American Ornithologists' Union was held in Detroit, Michigan, from October 19 to 23, 1931. The meeting was largely attended and representatives were present from 21 states and 5 provinces. The headquarters were at the Book-Cadillac Hotel where the business sessions and most of the public sessions were held. On Wednesday the meetings were held at Ann Arbor, in the Museum of Zoology of the University of Michigan, and on Thursday afternoon the closing session was held at the Cranbrook Institute of Science at Bloomfield Hills.

The officers were reelected for 1932 as follows: *President*, Joseph Grinnell, Berkeley, California; *Vice-presidents*, A. C. Bent, Taunton, Massachusetts; J. H. Fleming, Toronto; *Secretary*, T. S. Palmer, Washington, D. C.; *Treasurer*, W. L. McAtee, Washington, D. C. Additional members of the council, James P. Chapin, Ruthven Deane, H. C. Oberholser, J. L. Peters, C. W. Richmond, T. S. Roberts and P. A. Taverner.

The election of new members included three corresponding fellows: Albert Collin, of Helsinki, Fin-

land; M. B. Kinnear, of London, and Ernst Mayr, of Berlin.

Five members elected were: Clinton G. Abbott, San Diego; O. L. Austin, Jr., North Eastham, Massachusetts; W. W. Bowen, Philadelphia; B. H. Christy, Sewickley, Pennsylvania, and Mrs. M. M. Nice, Columbus.

The Brewster Medal, awarded biennially for the most meritorious work on American birds, was awarded this year to Mrs. Florence Merriam Bailey for her "Birds of New Mexico."

On Friday, October 23, the members visited the Jack Miner Sanctuary, at Kingsville, Ontario, and after luncheon proceeded to Point Pelee National Park, where the afternoon was spent in observing the birds.

MEETING AT THE MISSOURI BOTANICAL GARDEN IN HONOR OF JULIUS SACHS

ACCORDING to a statement issued by Dr. George T. Moore, director of the Missouri Botanical Garden, the one hundredth anniversary of the birth of Julius Sachs occurs October 2, 1932. In view of the proximity of this date to the meeting of the American Association for the Advancement of Science in New Orleans, it seems suitable that some recognition be given to this anniversary during the holidays. Accordingly, the Missouri Botanical Garden is planning to keep "open house" on Sunday, December 27, for botanists who are planning to attend the meetings at New Orleans.

Guides will be on hand for the outside gardens and conservatories, and will leave the main gate at Tower Grove Avenue and Flora Place on the hour from 9 A. M. until 12 noon. The library and herbarium will be open during the morning and members of the staff will be in attendance to furnish information or assistance. There will be a special exhibit of books of historical interest relating to the development of plant physiology. Luncheon will be served in the conference room of the administration building at 1 P. M.

There will be a program of scientific papers in the lecture hall of the old museum building at 2 P. M.:

"Plant Physiology as Sachs Found It," by Dr. Ernest S. Reynolds, Washington University.

"The Contributions of Sachs to Plant Physiology," by Dr. Charles F. Hottes, University of Illinois.

"Progress in Plant Physiology since Sachs," by Dr. D. T. MacDougal, Carnegie Institution.

The best train for New Orleans leaves at 6:30 P. M., Sunday, arriving at New Orleans at 6 P. M., Monday. The program will be completed in ample time to admit of taking this train. Tickets can be purchased from St. Louis to New Orleans over the Missouri Pacific Railroad. A representative of the railroad will be at the garden to arrange sleeping car reservations, for which ample space will be reserved.

THE THOMAS CHROWDER CHAMBERLIN SCIENCE LIBRARY

ON October 20 Beloit College dedicated a new science library to the memory of Dr. Thomas Chrowder Chamberlin, graduate of Beloit College in 1866 and later a member of the faculty. This library has been built around Dr. Chamberlin's private library which was given to Beloit by Dr. Rollin T. Chamberlin in 1930 and has been named the Thomas Chrowder Chamberlin Science Library. Professor Chamberlin also sent \$1,000 to supplement this collection of books in the field of geology.

The disposal of this gift brought home to the college the advantages which might be obtained by organizing a science library to be housed in the Pearsons Hall of Science, and to be administered as a branch of the Beloit College Library. Through the kindness of the heirs of the late William E. Hale, a gift of \$11,404 was used for the reconstruction of the small auditorium in Pearsons Hall of Science, the sloping floor being replaced with a cement floor and the entire surrounding brick walls being made more nearly fireproof. The basement below was walled up and the construction was so carried out that the lifting of a cement slab will later, with the growth of the library, make possible an extension of stacks into the lower floor. In the reconstruction, a modern double sky-light was installed and ventilation was secured through the installation of several univert units. Library equipment, including approved metal stacks, attractive oak tables and Windsor chairs, suitable periodical and display book racks, with complete card index files, have been secured.

The library already contains 13,000 volumes. It makes possible an ideal relation between laboratories and reference books through its nearness to the various scientific laboratories.

SCIENTIFIC NOTES AND NEWS

THE Penrose Medal of the Geological Society of America, given for outstanding service in the advancement of geological science, has been awarded to

Dr. William Morris Davis, professor emeritus of geology of Harvard University. Presentation will be made on December 30 at the annual dinner of the

society to be held in Tulsa in connection with the forty-fourth annual meeting. The medal was founded in 1926 by the late Dr. R. A. F. Penrose, Jr.

THE Rockefeller Institute for Medical Research on November 20 honored Dr. Theobald Smith, member emeritus of the institute and vice-president of its board of scientific directors, at a dinner which was held at the department of animal and plant pathology near Princeton, New Jersey. The dinner marked the formal opening of the Theobald Smith House, which was for many years the residence of Dr. and Mrs. Smith while he served as the director of the department and has recently been remodeled to serve as a staff house for the scientific workers. Dr. Simon Flexner, director of the Rockefeller Institute, presided. In addition to Dr. Theobald Smith, speeches were made by Mr. John D. Rockefeller, Jr., and Dr. William H. Welch.

DR. WILLIAM KELTNER ROBBINS, known for his work on textile coloring, died at Manchester, N. H., on November 26, aged seventy-six years. Dr. Robbins was chief chemist of the Amoskeag Manufacturing Company.

DR. GEORGE WILLIAM MYERS, professor of the teaching of mathematics and astronomy at the College of Education of the University of Chicago from 1901 until 1929, died on November 23 at the age of sixty-seven years.

THE death in the Crimea, near the Nikitsky Gardens, is announced of Dr. S. Kostychev, known as an authority in plant physiology.

MAJOR GENERAL SIR DAVID BRUCE, distinguished for his work on tropical diseases, president of the British Association for the last Toronto meeting, died on November 27 at the age of seventy-six years.

MEDALS of the Royal Society were awarded at the anniversary meeting on November 30 as follows: Royal Medals to Sir Richard Glazebrook, for his distinguished work in experimental physics, and to Professor W. H. Lang, for his work on the anatomy and morphology of the fern-like fossils of the Old Red Sandstone; the Copley Medal to Sir Arthur Schuster, for his distinguished researches in optics and terrestrial magnetism; the Davy Medal to Professor A. Lapworth, for his researches in organic chemistry, particularly those in connection with tautomerism and the mechanism of organic reactions; the Sylvester Medal to Professor E. T. Whittaker, for his original contributions to both pure and applied mathematics, and the Hughes Medal to Professor W. L. Bragg, for his pioneer work on the elucidation of crystal structure by x-ray analysis.

OFFICERS of the Royal Society have been elected as

follows: Sir Frederick Hopkins, *president*; Sir Henry Lyons, *treasurer*; Dr. H. H. Dale and Sir Frank Smith, *secretaries*; Lord Rayleigh, *foreign secretary*; *other members of council*.—Dr. J. A. Arkwright, Professor G. Barger, Professor W. L. Bragg, Professor E. P. Cathcart, Mr. A. C. G. Egerton, Mr. R. H. Fowler, Professor E. S. Goodrich, Professor G. H. Hardy, Professor W. N. Haworth, Professor C. E. Inglis, Professor O. T. Jones, Sir Thomas Lewis, Dr. N. V. Sidgwick, Professor A. G. Tansley, Professor G. I. Taylor and Professor D'A. W. Thompson.

PROFESSOR K. FUJII, of Tokyo; Professor Victor Grégoire, of Louvain, and Professor O. Rosenberg, of Stockholm, have been elected honorary fellows of the Royal Microscopical Society.

THE Royal Society of Sciences in the Dutch Indies has elected as foreign corresponding members the following: Dr. A. Ernst, Zurich; Dr. A. Lacroix, Paris; Dr. T. Wayland Vaughan, La Jolla, Calif.; Dr. J. Boden Kloss, Singapore; Professor G. Elliot Smith, London; Mr. J. B. Scrivenor, Natu Gajah, F. M. S.; H. Tanakadate, Sendai, Japan; M. F. Blondel, Hanoi, Indo-China, and Dr. J. Wanner, Bonn. The total number of corresponding members permissible in the society is thirty. The number was brought up to nineteen at the election in December, 1930.

PROFESSOR HUBERT GREGORY SCHENCK, of the department of geology of Stanford University, has been elected to membership in the Geological Society of France.

THE annual Chilean Nitrate of Soda Nitrogen Research Award was made at the annual meeting of the American Society of Agronomy in Chicago to Dr. W. H. Pierre, of the University of West Virginia, and Dr. Hans Jenny, of the University of Missouri.

DR. WILLIAM PENN BROOKS, Amherst, Massachusetts, professor of agriculture emeritus and formerly director of the Massachusetts Agricultural Experiment Station, celebrated his eighty-first birthday on November 19.

PROFESSOR ALBERT EINSTEIN has been appointed the Rouse Ball Lecturer at the University of Cambridge for the year 1931-1932 by the faculty board of mathematics.

DR. HARRY H. PLASKETT, professor of astrophysics at Harvard University, has been appointed Savilian professor of astronomy at the University of Oxford and director of the observatory to succeed the late Professor H. H. Turner. The appointment dates from January 1. Professor Plaskett will not, however, assume the professorship until June as he is completing arrangements for a new sixty-inch tele-

scope in South Africa and supervising the construction of a spectrograph in Cambridge.

ASSOCIATE PROFESSOR OTTO STRUVE, of the University of Chicago, has been appointed assistant director of the Yerkes Observatory. Professor Frost has been making a satisfactory recovery from recent illness at the Billings Hospital, and expects to resume his duties as director within a short time.

F. W. HODGE will terminate his service with the Museum of the American Indian, New York City, at the close of the present year to assume the directorship of the Southwest Museum at Los Angeles, California.

As visiting professors at the Johns Hopkins University for one year there have been appointed Dr. Georg Tischler, professor of botany at Kiel; Dr. William J. Cooper, U. S. Commissioner of Education, and Professor Edward L. Thorndike, of Teachers College, Columbia University.

DR. FREDERIC M. HANES will be acting professor of medicine and head of the medical service in Duke Hospital while Dr. Harold L. Amoss is this year visiting professor of medicine in the Peiping Union Medical School in China.

M. F. MILLER, assistant dean of the College of Agriculture and chairman of the department of soils of the University of Missouri, has been designated acting dean and director during the six months' absence in Europe of Dr. F. B. Mumford for a study, mainly in England, France and Germany, of world conditions affecting American agriculture.

DR. SAMUEL VAN VALKENBERG, of Detroit City College, has been appointed associate professor of climatology and regional geography at Clark University, succeeding Dr. Charles F. Brooks, who assumes the directorship of the Blue Hill Observatory in February. Dr. Van Valkenberg was a member of the faculty of Clark University from 1927 to 1929. Dr. Wallace B. Atwood, son of President Wallace W. Atwood, has been appointed assistant professor of physiography and regional geography.

JOHN WAGNER, JR., civil engineer, industrial agent of the Reading Company, has been elected president of the Wagner Free Institute of Science, Philadelphia, succeeding his father, Mr. Samuel T. Wagner, who died on August 7.

H. C. DIEHL, senior physiologist, U. S. Department of Agriculture, has been placed in charge of the frozen pack investigations of the department, with headquarters at Seattle, Washington, where the Bureau of Plant Industry has established a laboratory designed for research in the freezing preservation of fruits and vegetables. Mr. Diehl was formerly in

charge of the maturity handling and storage investigations of the department with headquarters at Wenatchee, Washington.

THE following appointments have been announced at Tulane University: Dr. Francis H. Wilson, formerly associate professor of botany, University of Richmond, assistant professor of zoology; Dr. Dorothy W. Seago, formerly associate professor of psychology at North Carolina College for Women, assistant professor of psychology at Newcomb College; Dr. Bruce P. Webster, formerly instructor in medicine at the College of Physicians and Surgeons, Columbia University, assistant professor of medicine; Dr. William H. Perkins, instructor in medicine, has been promoted to a professorship of preventive medicine and head of the department in the School of Medicine.

At the annual meeting of the American Society of Agronomy held in Chicago on November 19 and 20 the following officers were elected for the coming year: *President*, Dr. P. E. Brown, Iowa State College, Ames; *First Vice-president*, Dr. S. A. Waksman, Agricultural Experiment Station, New Brunswick, N. J.; *Second Vice-president*, Professor George Stewart, U. S. Forest Service, Ogden, Utah; *Third Vice-president*, R. I. Throckmorton, Kansas State Agricultural College, Manhattan, Kansas; *Fourth Vice-president*, Dr. M. A. McCall, Bureau of Plant Industry, Washington, D. C.; *Secretary-Treasurer*, Dr. F. B. Smith, Iowa State College; *Editor*, Professor J. D. Lockett, Agricultural Experiment Station, Geneva, New York.

At the meeting held on November 12 the Washington Section of the American Chemical Society elected the following officers: *President*, E. Wichers; *Secretary*, J. H. Hibben; *Treasurer*, O. E. May; *Councillors*, S. F. Acree, B. H. Carroll, R. E. Gibson, H. T. Herrick, P. E. Howe; *Executive Committee*, M. S. Anderson, J. H. Bruun, J. F. Couch, R. Gilchrist, R. M. Hann and A. R. Merz.

Nature reports that at the annual statutory meeting of the Royal Society of Edinburgh held on October 26 the following council was elected: *President*, Sir E. A. Sharpey-Schafer; *Vice-presidents*, Professor F. G. Baily, Professor T. J. Jehu, Professor J. H. Ashworth, Dr. A. Logan Turner, Dr. J. B. Clark, Professor James Ritchie; *General Secretary*, Professor R. A. Sampson; *Secretaries to Ordinary Meetings*, Professor C. G. Darwin and Professor F. A. E. Crew; *Treasurer*, Dr. James Watt; *Curator of Library and Museum*, Professor D'Arcy W. Thompson; *Councillors*, Professor James Drever, Mr. A. H. R. Goldie, Dr. R. A. Houston, the Hon. Lord Sands, Dr. Murray Macgregor, Dr. A. Crichton Mitchell, Pro-

Professor P. T. Herring, Sir Thomas H. Holland, Professor James Kendall, Professor T. M. MacRobert, Professor Godfrey H. Thomson, Dr. Malcolm Wilson.

THE Committee on Scientific Research of the American Medical Association has extended to Dr. Timothy Leary, of Boston, a grant-in-aid for a study of the influence of alcohol and of insulin upon the deposition of cholesterol in the animal body.

A GRANT of \$600 has been made to Dr. Reginald D. Manwell, of the department of zoology in the College of Liberal Arts in Syracuse University, by the National Research Council for the continuation of studies on the chemotherapy of avian malaria. This is the second grant made by the council to Dr. Manwell for this purpose.

PROFESSOR DOUGLAS JOHNSON, of Columbia University, devoted part of the past summer to a reconnaissance study of coastal terraces along the Atlantic and Gulf Shores, under the joint auspices of the American Geographical Society, the Carnegie Institution and Columbia University. In September he attended the International Geographical Congress in Paris as president of the Section of Physical Geography.

VILHJALMUR STEFANSSON, associate in anthropology at Harvard University, will give at Wellesley College in the near future a series of lectures on his archeological expeditions to Iceland, Eskimo life in the Mackenzie Delta, and other topics dealing with his explorations.

DR. HARRY N. HOLMES, professor of chemistry and head of the department of chemistry, Oberlin College, on November 14 delivered an address before the Royal Canadian Institute entitled "The Applications of Colloid Chemistry."

DR. WILLEM DE SITTER, of the Leiden Observatory, Holland, lectured at the Perkins Observatory, Delaware, Ohio, on November 23, on "The Size of the Universe." The lecture was the second of the series held on the affiliated program between the observatory and the Graduate School of Ohio State University.

THE Third International Congress for Light will be held in Copenhagen from August 15 to 18, 1932. The president is Professor Axel Reyn, of Copenhagen. The chairman of the American Committee is Dr. Alfred F. Hess, of New York. The main subjects for discussion will be: (a) "The Rôle of Pigment in Light Biology"; (b) "The Systemic Action of Light in Tuberculosis"; (c) "Heliotherapeutic and Climatology Research in Relation to Public Health."

THE annual meeting of the National Council of

Geography Teachers will be held at State Normal College, Ypsilanti, Michigan, on Monday and Tuesday, December 28 and 29.

THE fourth national organic chemistry symposium of the American Chemical Society will be held in the Sterling Chemistry Laboratory of Yale University from December 28 to 30. Sixteen papers will be presented by the following: Professor Roger Adams, University of Illinois; Professor H. B. Adkins, University of Wisconsin; Professor M. T. Bogert, Columbia University; Professor H. T. Clarke, Columbia University; Dr. W. H. Carothers, research chemist, du Pont Company, Wilmington, Del.; Professor J. B. Conant, Harvard University; Professor L. F. Fieser, Harvard University; Professor R. C. Fuson, University of Illinois; Professor H. Gilman, Iowa State College; Professor C. S. Hudson, National Institute of Health, Washington, D. C.; Professor J. R. Johnson, Cornell University; Professor T. B. Johnson, Yale University; Dr. P. A. Levene, Rockefeller Institute, New York City; Professor C. S. Marvel, University of Illinois; Thomas Midgley, Jr., Worthington, Ohio, and Dean F. C. Whitmore, Pennsylvania State College. Dr. Levene will address an evening session. Another evening meeting will be in charge of Professor Fieser.

THE U. S. Civil Service Commission announces open competitive examinations for the position of associate physicist (sound, or any other specialized branch of physics) and assistant physicist (any specialized branch of physics). Applications for the positions must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than February 2. The examination is to fill vacancies in various services. The entrance salary for associate physicist is \$3,200 a year and for assistant physicist is \$2,600 a year. Competitors will not be required to report for examination at any place, but will be rated on their education and experience, and on a thesis, reports or published writings.

MRS. FLORA FULLERTON MAXWELL, who was killed recently in an automobile accident, left half of her estate, estimated at \$250,000, to Yale University. The gift will be known as the Flora Fullerton Maxwell Fund and the income will be paid annually to worthy young men studying in Yale College.

A DECREE has been passed on the motion of the warden of Wadham College, University of Oxford, to record the grateful thanks of the university to Professor J. Mark Baldwin for a gift of £1,000 for the capital endowment of the Edward Bagnall Poulton Fund, which was established by Professor Baldwin in

1920 in honor of his friend, the present Hope professor, with the purpose of promoting the study of evolution.

THE League of Nations has accepted the proposal of the Brazilian Government to erect, at Rio de

Janeiro, an international institution for the investigation of leprosy.

THE buildings of the Medical Faculty at Seville have been almost entirely destroyed by fire entailing a loss of about two million pesetas.

DISCUSSION

GARDINER ON CORAL REEFS

AFTER "thirty-five years of interest in the problems of coral reef formation," including "five years' work on the actual reefs," the author of the great monograph on the Maldive and Laccadive archipelagoes has at last given the hoped-for summary of his views concerning reefs, structures which are important not only in themselves but even more for their relation to the physical properties and history of the earth as a whole.¹ While making the essentials of the subject clear to any educated reader, this admirable volume is full of meat for professional biologists and geologists. Most of its pages are devoted to giving a remarkably complete picture of the marine and dry-land biology. The present note does not attempt an abstract of the wealth of observations made by the distinguished professor at Cambridge on reef organisms, but is limited to an outline of his conclusions specially significant to geologists.

(1) While Professor Gardiner agrees that nullipores are essential to reef-strength, he points out that the dominant builders below the depth of four to six fathoms are corals, and therefore considers the old name, coral reef, quite justified, especially for the Indo-Pacific region.

(2) The islets of atoll and barrier reefs are chiefly composed of organic material deposited below sea-level and became dry land through a relatively recent, general, negative shift of sea-level. This was not greater than about 20 feet, but probably varied somewhat from region to region in the tropical belt.

(3) True reefs are geologically young. "There is no proof of any atoll or barrier reef having originated previous to the Pleistocene" (p. 151) or "late tertiary" (p. 115). The indigenous fauna and flora of atoll islets "give no support to the idea that they were ever increased from those of larger lands, which have disappeared. . . . Indeed, there is not a single constituent of the fauna and flora of atoll islets that gives evidence for their existence for more than a few hundred years" (p. 44). Like Mayor, Professor Gardiner is convinced that reefs grow rapidly enough

to permit belief in the late-Glacial or post-Glacial origin of those now visible (p. 66).

(4) Atoll reefs rest on plateaus that had been prepared at depths of fifty fathoms, or somewhat less, below sea-level (pp. 143-144). They "form over 90 per cent. of coral structures in island groups of the Indo-Pacific" (p. 16).²

(5) Some lagoons show moderate enlargement by solution of their calcareous walls.

(6) Those basins are not being filled at an important rate by detritus washed over the encircling reefs. "There is no such general filling in of lagoons by coral growth and by sediment as suggested" by the Darwin-Dana theory of subsidence—a fact that "kills" the theory (p. 146). Nor, in the reviewer's opinion, does it favor Molengraaff's explanation of atolls by the independent, isostatic sinking of volcanic cones.

(7) The fronds of the shallow-water *Halimeda*, dredged from depths of hundreds of fathoms, had been dragged thither by wave, current and gravity, and do not indicate subsidence of adjacent reef structures. This statement should give pause to those who believe that the discovery of shallow-water foraminifera in the deeper part of the bore-hole inside the Great Barrier Reef of Australia proves subsidence for the Australian shelf.

(8) After much study of the core of the famous Funafuti boring, Professor Gardiner concludes that it penetrated talus, not a sunken reef of corals in place, and hence does not prove subsidence.

(9) Though the origin "of the isolated mountains and of the mountain ranges of the Indo-Pacific is still left beyond the limits of our knowledge" (p. 159), he adopts the prevailing theory that the "atoll-crowned mountains of the Pacific" are volcanoes (p. 162).

(10) The Glacial-control theory "accounts for the underlying Indo-Pacific reef-platforms even to details."

(11) But, he adds, "If we regard the question of

¹ "Coral Reefs and Atolls," being a course of lectures delivered at the Lowell Institute at Boston, February, 1930, by J. Stanley Gardiner (xiii + 157 pages of text, 15 plates, 33 text figures). Price in the United States (The Macmillan Company), \$4.25, too high for ready sale!

² Professor Gardiner does not mention the relatively recent evolution of the reef-building species of corals. Before this late epoch in earth-history, perhaps as far back as Archean time, volcanic cones and other lands, emerged, one after another, in the tropical belt of the ocean and suffered wave-planation during many millions of years. The reviewer knows of no fact that forbids one to assume such pre-Cretaceous abrasion as important in the formation of many atoll-bearing, submarine plateaus, especially those of the Pacific region.

the formation of the foundations of coral reefs honestly, we are forced to admit that all our theories and considerations are mere camouflage for our lack of knowledge" (p. 160).

REGINALD A. DALY

HARVARD UNIVERSITY

TREE TWIST

ON reading the query on tree twist in SCIENCE, the idea struck me that I was particularly well situated to observe this phenomenon. This is due to the fact that in north China (1) burial grounds are planted with trees symmetrically arranged, resembling an orchard, (2) these burial grounds stand out in the plain as islands at sea with no shelter for rods to miles about them (3) that most of them are planted with one species of tree: the oriental white cedar or Arbor Vitae (*Thuja orientalis*). The advantages thus secured are that of isolation, so that only meteorological and edaphic forces would affect the trees. There is no slope, the substratum being an alkaline plain. The trees are equally spaced so that if the wind is a factor in causing twist, the corner trees should be most twisted and the central ones least, while the others would be progressively less twisted. The soil in these small plots (the largest observed was about 20 by 37 yards) would be the same, being loess with a depth of ten to twenty or more feet. In places this loess is interrupted by beds of conglomerate which would then affect the entire ground as a unit. The species of tree is so "thin skinned" and the bark so striped as to make twist in the wood, and in the "insertion" of the branches, easily observable. The climate is semiarid with heavy summer rainfall and very little rain the rest of the year. Throughout the spring there are high winds blowing from the south and southwest for one to three days' duration. These winds are so strong and dry and hot as to cause all trees of the region to develop to the northward. The Arbor Vitae thus have the boles bent often very strongly to the north. This bending is most accentuated in the taller trees and at their tops.

Unfortunately such a plantation does not usually develop uniformly. The trees which die out are later replaced. Moreover at times of financial stress, a tree here and there will be taken down and some time after replaced by young trees. However, these factors can be taken into consideration and due allowance made, or observations in such groves can be checked by observations in groves that have had no such interference.

The present notes are based on charts plotted for four such burial grounds lying three quarters of a mile south of the Shantung Christian University campus (Tsinan, Sung.) near the village of Djang

Djia, as well as on several isolated trees and a double row of fourteen trees.

The twist in *Thuja orientalis* of this region is to the left. In *T. occidentalis* reported in SCIENCE for May 22 it is to the right. Of 438 trees observed: 272 had the boles twisted to the left, 157 were not twisted, six had only the lowest two feet twisted, one was twisted in different directions every three or four feet and two were twisted to the right. There was no correlation whatever with exposure. Similarly there was no correlation with the lean or inclination of the tree. Some had a slight twist at the lowest two feet but were straight the rest of the way. Large old trees were usually free from twist! Is twist then a hang-over of seedling development, which carries over more strongly in some individuals than in others? Certainly it is not related to wind or other obvious environmental factors.

In one of the groves the two south rows and two north rows consisted of *Juniperus chinensis*. Of the 38 trees standing, 20 had the boles twisted to the left, 16 were straight and two were twisted to the right. There was correlation with neither exposure nor sex.

The charts of these groves are to be deposited with Professor Nichols at the Osborn Botanical Laboratories of Yale University.

ARTHUR PAUL JACOT

TOWN OF MONROE, CONN.

MARINE TERTIARY IN ARIZONA¹

IN April, 1931, while studying the geology and mineral deposits of southern Yuma County, Arizona, the writer found a fossiliferous Tertiary formation that hitherto had not been recognized. This formation outcrops from beneath later silts, sands and gravels, as several areas in the broad, terraced, dissected plains that border the Colorado River north of latitude 33° 10'. It consists of well-stratified, weakly consolidated conglomerates, sandstones and marls, alternating with chalky and dense limestones to make up a total maximum apparent thickness of approximately 1,000 feet. Fossils from its calcareous members were submitted, through Dr. John C. Merriam, of the Carnegie Institution of Washington, to Dr. W. P. Woodring, of the U. S. Geological Survey. Dr. Woodring² identified the following forms: Cerithid, *Pisidium* (?), *Corbicula* (?), barnacle, ostracode, calcareous algae, and *Chara* (?) encrusted with algae (?). These forms, he states,² show that brackish waters once reached the region, but do not determine the age. He further states:² "Perhaps this marine invasion is the same as the one recorded in the southwestern part of the Colorado Desert, (California) which I regard as Miocene, but which most

¹ Published with permission of the director of the Arizona Bureau of Mines, University of Arizona.

² Written communication.

California geologists consider Pliocene (See Carnegie Inst. Washington Pub. 418, pp. 1-25. 1931)."

Heretofore, no Tertiary of definitely marine origin has been known to occur in Arizona, and none nearer than the Salton Sea-Carrizo Creek region, some sixty miles west of the Colorado River. John Brown,³ C. P. Ross,⁴ and others have suggested the possibility that, in late Tertiary time, the Gulf of California may have extended far up the drainage of the Colorado River. East of Parker, R. C. Blanchard⁵ collected *Bittium* and a probable young *Corbicula*. In the same area, C. P. Ross⁶ found what appeared to be a minute *Corbicula*. West of the Colorado River, opposite Cibola, Brown⁶ gathered the same material as Ross. Although *Bittium* and *Corbicula* are prone to inhabit brackish waters, Ross⁷ did not regard the presence of the one *Bittium* and the probable *Corbicula* as conclusive evidence of the character of the waters in which these beds were deposited. The barnacles found by the writer, however, are unquestionably marine.

Very little faulting, no folding, and only minor tilting are apparent in this formation. Near Parker, it overlies an extensive, tilted series of red beds and underlies basalt. East and southeast of Cibola, it abuts against and overlies unconformably the roughly eroded slopes of granite, schist, and lavas of present-day mountains. Because of such barriers, its eastward extension in Arizona may not have been great, and no traces of it were found along the river south of, approximately, latitude 33° 10', where its limiting mountains converge to the river's channel. West of the Cibola region, however, no continuous mountain barriers are apparent for a great distance. John Brown's map⁸ of the Salton Sea region shows many wide passes between the mountain ranges of that part of the region between the Salton Sea and Colorado River. Consequently, this sea-way probably had its outlet westward towards the present Salton-Carrizo region, and thence southeastward to the Gulf of California, rather than directly along the present Colorado River channel.

The writer plans to carry out further study of this formation, in as much as it offers to shed much needed light upon the Tertiary history of western Arizona.

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³ U. S. Geol. Survey Water-Supply Paper 497, p. 46, 1923.

⁴ U. S. Geol. Survey Prof. Paper 129, pp. 195-196, 1922.

⁵ Columbia Univ. Contr. Geol. Dept., vol. 26, No. 1, p. 39, 1913.

⁶ See U. S. Geol. Survey Prof. Paper 129, pp. 189-190, 1922.

⁷ U. S. Geol. Survey Prof. Paper 129, p. 195, 1922.

⁸ U. S. Geol. Survey Water-Supply Paper 497, Pl. 12, 1923.

THE SO-CALLED AUTOXIDATION OF CYSTEINE

IN a recent paper Gerwe¹ presents figures to show that the oxidation of neutralized cysteine hydrochloride is much too rapid to be accounted for by the extremely minute amounts of iron which may be present in a pure preparation, and concludes, therefore, that pure cysteine is autoxidizable. It is very surprising that he should make this conclusion without considering the possible effect of copper in the oxidation of cysteine. Gerwe² states in a previous paper concerning the preparation of iron-free cysteine hydrochloride by crystallization from HCl that small traces of copper which may have been present in the crude preparation were completely removed long before the iron in the early crystallizations. He gives no data to substantiate this statement.

I wish to call attention to several facts in a paper³ which I published about a year ago on the catalytic action of copper in the oxidation of cysteine which bear on this question. The method which I used for the preparation of cysteine at that time is very similar to the one which Gerwe describes in his recent paper. The oxygen consumption of my sample was 1.2 cmm per hour for 8 mg cysteine hydrochloride, while Gerwe reports his to consume 2.2 cmm per hour for 10 mg cysteine. My sample was, therefore, equally as pure as his preparation. When pyrophosphate, which increases the activity of copper, was added to my sample of cysteine, there was a considerable increase in the oxygen uptake. This shows that the impurity which caused the residual oxidation was undoubtedly copper. If the metal had been iron, the oxidation would have been retarded rather than increased.

Gerwe found the oxygen consumption of 10 mg of cysteine to increase 5.22 cmm per 0.0001 mg Fe. I found the oxygen uptake for 8 mg of cysteine to increase 86.0 cmm for every 0.0001 mg Cu. Therefore copper is at least 16 times as active as iron. Gerwe concludes that the amount of iron necessary to account for the oxidation of his pure cysteine would be 44 times as much as could possibly be present. Since copper is so much more active than iron, the presence of this element in slightly larger amount than that calculated for iron would explain the observed oxidation of the cysteine.

A catalyst does not initiate a chemical reaction but merely alters the speed of the reaction. Naturally then even absolutely pure cysteine must undergo some oxidation or else the rate of oxidation could not be increased by the addition of catalysts. An oxygen uptake of about 2 cmm of O₂ per hour for 10 mg of cysteine is a very slow rate of oxidation (the 10 mg

¹ E. G. Gerwe, *J. Biol. Chem.*, 92: 399, 1931.

² E. G. Gerwe, *J. Biol. Chem.*, 91: 57, 1931.

³ C. A. Elvehjem, *Biochem. J.*, 24: 415, 1930.

of cysteine would be completely oxidized only after a period of about 7 days) but if the cysteine were completely metal-free the oxygen consumption would undoubtedly be still less. The oxidation which has been observed by Gerwe can not be called autoxidation

until the presence of other metals such as copper and manganese has been studied.

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SPECIAL ARTICLES

A NEW MUTATION IN THE HOUSE MOUSE (*MUS MUSCULUS*)

IN the fall of 1926 a female mouse of unusual color, caught in the country several miles from the nearest town, was brought to our laboratory. The eyes were pink, indistinguishable from the eyes of the common pink-eyed varieties but the coat color, though plainly agouti, was lighter than that of a pink-eyed black agouti.

A mating of this animal with a pink-eyed brown non-agouti produced young phenotypically like the ordinary wild. This result indicated that this new mutation was different from the common pink-eyed form. Further matings of the F_1 's produced dark and pink-eyed agoutis, blacks, browns and the new mutation. This new mutation which is tentatively called p_2 is not in the pink-eye (P , p), color (C , c^h , c^d , c), or dilution (D , d) series.

The new p_2 gene seems to dilute both the yellow and black or brown in agouti individuals. So far a non-agouti in the new mutation has not been found. The combination of the new pink-eye gene and extreme dilution $c^d c^d p_2 p_2$ produces an animal with very little color and eliminates pigment from the ears. A complete report of the inheritance of this new character together with linkage studies will be published later.

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"AT THE TOP IS MAGIC"

IT is sometimes difficult to understand how certain books can get published, especially by reputable publishers. Many readers of *SCIENCE* will doubtless raise that question if they dip into "The Adventure of Mankind," translated by Robert Bek-Gran from the original German of Eugen Georg.¹ The "blurb" on the jacket states that "to read it thoughtfully and to weigh its challenges should become the pleasure as well as the duty of all enlightened Americans."

Thumbing its pages as a botanist, though possibly not as an enlightened American, and more in pursuit of the promised pleasure than from a sense of duty, we read as follows:

The poplar tree fell ill throughout all of Middle Germany. None of the trees were raised from seed, but

¹ Putnam's, September 28, 1931.

were slips from a single mother tree; that is, they were a single individual distributed along a thousand highways. Suddenly these shoots perished, because the life energy of the mother plant (in the park of Wörlitz) became exhausted. Similarly the La France rose has languished, the blood-beeches have become decrepit, Malvasier grapes and Borsdorfer apples have turned sterile, and certain varieties of potato have disappeared, whenever they have been raised from shoots rather than, as formerly, from seeds of their kind. All these descendants, these grandchildren, these daughter cultures are but segments of a super-individual unity. When the root dies, they die (p. 234).

In other words if Ephraim Bull's original Concord grape-vine, at Concord, Massachusetts, should suffer from mildew all the other Concord grape-vines in the country, being descended from the Concord vine by cuttings, would also suffer from mildew; if the Concord grape should die that would be the end of all the Concord grapes in the world! This, we are told, is owing to the fact that there is a "rhythm of all living substances," "a magic bond which thus disregards space and time to unite the parent of a race, a family, a species with his heirs. Sometimes the links are so strong that the offspring perishes with the parent, the branch with the root, the daughter with the mother—be it plant, nation or civilization." A terrible thought for daughters!

What a pity that the French physiologist, Leo Erera, whose researches illuminated the subject of "physiological action at a distance," was not possessed of these data!

On page 246 we learn that, "The influence of the moon reaches the elemental depths of our animal and plant world," so that "The sap of trees rises and falls with the phases of the moon. If the walla tree of East Africa is felled at the time of the new moon, it produces splendid building material. Cut down at the full, it has no durability at all. Plants sown under the waxing moon are strongly rooted, but those set under its wane turn mostly to leaf; hence the first phases of the moon insure the best harvest."

This passage should insure a good sale of the book in Vermont, so that those engaged in the maple sugar industry will not fall into the error of tapping their trees at the wrong phase of the moon.

In the discussion of sunspots (p. 247) we note

that "The season of leafage or blossoming depends on them." This shatters the principle of photoperiodism, and incidentally ruins the reputation of the U. S. Bureau of Plant Industry for publishing reliable work.

The statements that "Matter is apparently formed by a kind of negative atmospheric pressure," and that "An atom of matter is nothing but a kind of emptiness in space" (p. 282) set us to wondering whether

ideas are sometimes emptiness, formed by a negative process, but this reverie was interrupted as our eyes caught the following on page 293: "Yes, there is a scale of scientific knowledge. And at its bottom we find the so-called 'exact' sciences. Further up are the occult sciences—paraphysics and parapsychology. At the top is magic!"

C. STUART GAGER

BROOKLYN BOTANIC GARDEN

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MAYAN SYMPOSIA AND EXHIBITS AT NEW ORLEANS

THREE sections of the American Association are planning symposia dealing with various phases of the civilization indicated by the Mayan ruins. On Tuesday afternoon Sections H, K and L will join for symposia on "Commerce, Trade and Monetary Units of the Mayas" and "Social and Economic Institutions of the Mayas." This program is in charge of Dr. Joseph Mayer, secretary of Section L of the association. Dr. Mayer is working in cooperation with Professor Frans Blom, director of the School of Middle American Research at Tulane, and with the officers of Section H.

At a dinner meeting on Tuesday evening the retiring vice-president of Section H, Dr. Carl E. Guthe, will deliver his address on the subject, "The Maya Lunar Count."

The opportunity which these meetings will afford for becoming familiar at first hand with the important work being done by the Department of Middle American Research of Tulane University is in itself a special attraction of the New Orleans meeting. In this connection the following information, supplied by Director Frans Blom, is particularly interesting:

In the latter part of 1924 a citizen of New Orleans created the Department of Middle American Research, with an endowment of \$300,000 and the purchase of the William E. Gates Library, containing about 3,500 books, pamphlets and autographs pertaining to the ancient and modern history of Mexico. Mr. Gates was appointed the first director of the new department and functioned as such until the first month of 1926.

The aim of the department is to conduct research in Middle America (i.e., Mexico), the Central American Republics and the West Indies, covering the ancient, the colonial and the modern history of these countries, their geography, botany, ethnology, etc., and to form a library which it is hoped will eventually be one of the most com-

plete and comprehensive on this subject in the United States.

In 1925 the First Tulane University Expedition departed from Vera Cruz, Mexico, and during six months conducted investigations, chiefly of an archeological and ethnological nature, in the southern states of Mexico and part of Guatemala. The results of this expedition were published in a two-volume report entitled "Tribes and Temples." During the same year an agronomical investigation was made in the State of Tabasco, Mexico, and the part of this survey which related to the possibilities of growing rubber was published in the U. S. Government report entitled: "Possibilities for Para Rubber Production in Northern Tropical America," U. S. Department of Commerce, 1926.

The library was augmented with the purchase of the George H. Pepper library.

After Mr. William E. Gates' departure, Mr. Frans Blom was appointed acting director, with Mr. Oliver La Farge II as his assistant. Later, Professor Hermann Beyer joined the permanent staff. Professor Rudolph Schuller conducted some temporary work, and from him a fine collection of pamphlets was purchased.

In 1927 the Third Tulane University Expedition, headed by Mr. La Farge, and with Mr. Douglas Byers as assistant, spent several months in the highlands of Guatemala, investigating the Indian population of the town of Jacaltenango.

During the same year the Sedly Mackie Library was purchased, and through this purchase the department's library with one stroke attained an important position. The Gates Library contained some fine manuscripts and linguistic material; the Pepper Library added much valuable pamphlet material, specially of a more general nature; and the Schuller collection, made in distant parts of Central America, contributed many rare imprints. Finally the Mackie library presented a most astoundingly complete gathering of the classics of Middle American Research, with an abundance of rare items.

It was evident that the limited funds of the department would not permit the purchase of museum specimens, the financing of expeditions and the upkeep of a library at the same time, and as it is just as evident that the library is the foundation for sound research,

all stress was thrown on the formation of a first-rate collection of books. Funds for expeditions were raised outside of the regular income. It soon was noted that New Orleans, as the gateway to Middle America, contained several private collections of archeological and ethnological objects, most of them comparatively small, but which, when brought together, would form an excellent nucleus for a Middle American museum. Fortunately, the greater part of the local collectors were well disposed toward the department, and thanks to their cooperation there has been gathered a small but quite select exhibit of objects from the field in which the department specializes.

Since it has become known that the department is interested in purchasing books and manuscripts relating to Middle American subjects, many rare items have been brought to New Orleans for sale. As a result it can now be stated that the library of the department contains one of the most complete collections of books and documents relating to the Maya, their country and history, among which are such rarities as the original of the famous documents of Mani in Yucatan, written in the Maya language, but in Latin characters (the oldest document of its type known, dated 1557), as well as several other sixteenth century documents in the Maya language. The collection of Nahuatl linguistics is remarkably complete. From the Gates library came such rare things as the original manuscript to Gilberti's vocabulary of the language of Michoacan, Mexico, and an original Father Olmos MS. The Mackie library held such a rare and charming item as the original edition of Vargas Machucas: *Milicia, Indiana*, printed in 1599, and with a full manuscript page in the hand of Robert

Southey, poet laureate, author of "Maddox," who bought the book in Milan on the 16th of June, 1817.

During the New Orleans meeting of the American Association the collections and library of the Department of Middle American Research will be open, and a special exhibition will be made of the rare manuscripts, books, pamphlets and bindings, all intimately connected with truly American history and development.

In addition to this exhibit of the library of the Department of Middle American Research, the director plans an exhibit in connection with the association's scientific exhibition at the Municipal Auditorium.

The Carnegie Institution of Washington, which has been very active in research work in Middle America, plans to use about 1,000 square feet in the scientific exhibit hall for an exhibition of some of its Mayan work.

Facilities for excursions to Mexico City and Yucatan will be available. The United Fruit Company's ss. *Olancho* will leave New Orleans on January 2 in the afternoon. The round-trip with visits to Mexico City, the Pyramids of Teotihuacan, Puebla and Cuernavaca included will cost \$165.00. Delegates will be returned to New Orleans on January 12. A boat for a ten-day round trip to Yucatan will leave shortly after the convention. The Yucatan trip with visits to various ruins, including Chichén Itzá will cost \$150.00.

THE NATIONAL ACADEMY OF SCIENCES

At the autumn meeting of the National Academy of Sciences, held in New Haven, Connecticut, on November 16, 17 and 18, the following papers were presented:

New concept of evolution based upon researches on the Titanotheres and the Proboscideans: HENRY F. OSBORN. (Printed in SCIENCE this week.)

The geological significance of the relief of western Central Asia: HELMUT DE TERRA (introduced by A. Knopf).

Coral reefs and sand reefs: W. M. DAVIS. Agassiz reported in 1898 that the southern or polar end of the Great Barrier Reef of Australia is determined by the equatorward drift of sands on a long sand reef, just as the northern or polar end of the much smaller coral reef of Florida is determined by the equatorward drift of sands on another long sand reef. Hedley, of Sydney, described in 1911 a remarkable increase of sea-bottom depth near the end of the Australian reef, as shown by comparing Admiralty surveys of 1869 and 1904; but he did not connect the increase of depth with wave action consequent upon the smothering of reef corals by encroaching sands. In certain areas the depth increase

was reported to be from 20 to 30 to 200 or 300 fathoms. Such an increase seems incredible, but on inquiring of the Admiralty Office in London I was informed that both the earlier and later surveys were regarded as authentic. And in reply to a recent inquiry a tracing has been generously sent me showing the position of the 100-fathom line off the coral reef end in 1869, 1898, 1904 and 1911, and 1928. The line retreated from 2 to 4 miles in the first interval and from 2 to 3 miles in the second; but it advanced 1 or 2 miles in the third or latest interval. Hence there seems to be no question whatever that rapid changes in depth have taken place in the sea floor hereabouts during the last half century, primarily involving strong increases and secondarily moderate decreases of depth. No similar increase of depth has taken place near the coral reef end along the Florida coast: charts showing detailed soundings made in 1852 and 1931, copies of which have been provided me by the superintendent of the U. S. Coast and Geodetic Survey, indicate only moderate increases of depth, probably because the Florida coral reef does not stand so far off shore as the Australian reef; so that when the Florida corals were smothered by sand drift no great change of sea-floor depth was called for. The encroachment of the Australian sand reef appears to explain why

the Great Barrier Reef fails by a hundred miles or more to reach the southern limit of reef growth in the adjoining sea. And if a significant encroachment has taken place in the 35 years between surveys of 1869 and 1904, a much greater encroachment should have occurred since the present relation of land and sea were assumed some thousands of years ago. Similarly, in view of the former and much longer enduring relation of land and sea levels in an earlier epoch before an eastward down-tilt of the land margin and the sea floor introduced the present relation, it may be inferred that the equatorward encroachment of the sand reef on the coral reef of that epoch may have measured many hundred miles. Various significant consequences follow from this inference; the most important of them is that the equatorward extension of the sand reef during that earlier epoch may perhaps account for the 173 feet of quartz sand found below 427 feet of coral-reef rock in a recent reef boring a long distance north of the present coral reef end. The object of the present note is to call attention to this possible explanation for the occurrence of the quartz sands as an alternative to various other explanations that have been proposed.

The use of rock crystal by Paleolithic man: GEORGE GRANT MACCURDY. One of the first steps in the ascent of the ladder of culture was taken when man began to find artificial means of adding to the effectiveness of the powers with which nature endowed him. He found by experience that a club supplemented arm strength and the sharp edge or point of a flint chip was more serviceable for cutting and puncturing than nails or teeth. Before the close of the Stone Age he had experimented successfully with at least forty-seven varieties of stone, but not all of these were in use by the close of the Paleolithic period. His sources of supply were chiefly from the silicates; carbonates were also used to a considerable extent. Of the silicates the species known as quartz was found to be especially adapted to the needs of primitive man. There are two varieties of quartz—cryptocrystalline and phenocrystalline. The great bulk of Stone-Age implements was made of cryptocrystalline quartz in the form of flint, chert, chalcedony, hornstone, quartzite, etc. By comparison, implements of phenocrystalline quartz are rare indeed. This is an oxide of silicon and is known as rock crystal; it was not in use prior to the Mousterian epoch. In other words, the chipping of tools from rock crystal began with Neanderthal man. In addition to its rarity rock crystal can not be chipped with the same ease as can flint. Complete tools of rock crystal dating back to the Mousterian epoch are exceedingly rare. We appreciate all the more the good fortune that has come to our American School of Prehistoric Research in the finding of seven perfect rock-crystal tools not only in one rock shelter but at one level in that rock shelter (the lower of two Mousterian levels). This shelter is known as Les Merveilles and is at Castel-Merle, near Sergeac (Dordogne). Upper Paleolithic deposits, especially Solutrean and Magdalenian, have yielded several rock crystal tools. Solutrean points of the laurel-leaf type, beautifully

chipped on both faces, have been reported—one from Le Placard (Charente), one from Liveyre, near Les Eyzies (Dordogne), and one each from Badegoule, Balutie and Laugerie-Haute (Dordogne). Three rock-crystal tools of Magdalenian age have been reported—one from Laugerie-Basse (Dordogne) and two of indifferent workmanship from Le Perron (Haute-Loire). Since three adjoining departments in south central France—Charente, Dordogne and Corrèze—have yielded practically all the Paleolithic tools of rock crystal known to date, a single center somewhere near the headwaters of the Vézère might well have been the source of rock crystal supply for the Paleolithic sites in question.

The supposed 2-meter eustatic bench of the Pacific shores: DOUGLAS JOHNSON (introduced by W. M. Davis).

The new ganometric method of subdividing Pliocene time based on the enamel foldings of the superior grinding teeth of the fossil and living elephants: HENRY F. OSBORN.

Clear Lake, California: W. M. DAVIS. Clear Lake, about 25 miles in length and from 20 to 40 feet in depth, lies 100 miles north of the Golden Gate and is the only lake in the Coast Ranges of California. It covers one of the many intermont basin plains of those mountains, and it results from a landslide of recent but unknown date which obstructed a deep gorge by which the drainage of the pre-lake plain was discharged through the enclosing highlands on the northwest. The lake rose until, on gaining a depth of 60 or 80 feet, it discovered in the mountains on the east another deep gorge, the head of which lies in a notch but little above the western base of those mountains. There the overflowing lake waters cut a cleft in the low notch at the gorge head and thus lowered the lake some 30 feet nearly to its present level. Later changes of small measure have been introduced by blasting away a rock barrier two miles west of the cleft and by building a dam in the cleft in order to control the outflow for irrigation. The prevailing level of the lake has thus been somewhat lowered. No other deep gorges are found in the basin-enclosing highlands. The two existing gorges, one of which formerly led out the drainage of the pre-lake plain, while the other now leads out the overflow of the post-landslide lake, appear to be of antecedent origin; but if so, the stream through the eastern gorge must have been defeated by basin-producing deformation at a well-advanced stage of basin development. Previous to that defeat, the single basin plain would appear to have had two outflowing streams of antecedent origin. This might seem impossible, if the smaller Laytonville basin plain, some 30 miles farther northwest, did not to-day possess two outflowing streams which follow deep-cut gorges and which are also apparently of antecedent origin, the divide between their heads being on the flat basin plain. Such paired basin-draining gorges can hardly be the result of erosion along fractures, for in that case they should be more numerous. They do not seem to be the work of consequent streams which flowed on the even surface of a previously deformed and completely filled basin, degrading the weak

filling of the basin in a broad plain, while they cut only narrow gorges in the resistant rocks of the basin-holding mountains; for there is no evidence that the basin was ever completely filled. On the other hand, it is difficult to imagine that the paired gorges are the work of small antecedent streams, for in that case two such gorges for a single basin would ordinarily be one too many. Yet, as the case now stands, an antecedent origin for the paired gorges seems more reasonable than any other. Hence the previously prepared eastern gorge, now followed by Clear Lake outlet, should be looked upon as the most remarkable feature of that interesting and picturesque district.

Submarine valleys: FRANCIS P. SHEPARD (introduced by W. M. Davis).

Biographical memoir of Raphael Pumpelly (read by title): BAILEY WILLIS.

*The incubating python: a temperature study:*¹ F. G. BENEDICT, E. L. FOX and V. COROPATCHINSKY. The incubating python, rarely observed in zoological parks, has been studied at the National Zoological Park in Washington, D. C. A thermoelectric survey of the temperature of the air around the snake and of the skin temperature of the snake (on the exposed surfaces, between the folds, and between the snake's body and the eggs) showed that the snake's temperature was definitely higher than that of its environment. Since under ordinary conditions snakes have a temperature a little lower than the environmental temperature, the incubating python is living under a special body-temperature regulation during the period of incubation.

The effect of exercise continued for several generations on the weights of the organs of the albino rat: HENRY H. DONALDSON. The captive albino rat of our laboratories is a mutant derived from the wild Norway rat. It differs from the parent stock in having a brain from 12 to 14 per cent. less in weight. This difference is not originally due to albinism, and therefore seems to be an effect of captivity. In captivity the rats usually have less opportunity for exercise than under wild conditions. The attempt was made, therefore, to determine whether an increase in the amount of exercise, by placing the animal in a cage with a revolving drum, would modify the weight of the brain. During the past 20 years three previous studies of this question have been made in our laboratory. They show that the weight of the brain may be thus increased from 2 to 3 per cent. The weight changes in other organs were also determined. All these experiments, however, were for one generation only. It was decided, therefore, to carry the same experiments through several successive generations, and thus determine whether there was any cumulative effect on the weight of the several organs. For this purpose two families were used—and each was carried through seven generations. All the rats lived their entire life in the revolving drum cage in which the exercise was taken voluntarily. One series of these was ex-

amined at 56 days of age—and the other at 220 days. The resulting changes in the fresh weights of 15 organs, including the brain, are here presented. The amount of difference in weight is represented by the percentage deviation of the tests from that of the controls, and it is seen in the 220-day series (chart) that in five organs of each sex (the gonads, kidneys, suprarenals, submaxillaries and heart), the changes are plus and large, while in two organs, the liver and the thyroid, they are minus—i.e., these latter organs have increased in weight less than the controls. This change in weight is mainly due to alterations in the size of the formed cells, combined with a possible increase in the number of cells in some glands. The changes induced by seven generations of exercise are not greater than those following one generation—and there is, therefore, no cumulative effect; nor is there any such effect as between the last and first generations in the series of seven. When the deviations for the sexes combined in the 220-day series are compared with those shown by the 56-day series, it is seen (chart) that the smaller amount of exercise taken by the 56-day series has yielded changes in general similar to those of the 220-day series, but for the most part less marked. Exercise thus produces weight changes in a number of organs in the albino rat. In man similar changes in the heart and musculature have long been recognized, but it is not possible to carry out on man experiments of the type here described. Nevertheless, the physiological similarities between the albino rat and man warrant the inference that similar organ changes would take place in man, and thus become a factor in bringing about the beneficial effects commonly recognized as following vigorous exercise.

Experiments on early stages of rat embryos: J. S. NICHOLAS (introduced by R. G. Harrison). Previous experiments by the author have shown that rat fetuses are capable of continuing their development after certain types of experimental interference. While the technical difficulties are great, the results warrant additional investigation of the possibilities of embryonic development in mammals under experimental conditions. The results here reported are founded on two series of experiments, (1) the production of extrauterine pregnancies, and (2) the transplantation of total embryos into regions outside the abdomen. In the first series the production of extrauterine pregnancy was attempted by transplanting the embryo to various structures within the abdomen. The embryos became implanted upon mesentery, but generally were rapidly resorbed. Since the segmentation stages of development occur in the Fallopian tube, the pregnant females were operated upon on the third day after fertilization and the uterine horns severed from their upper connections with the tube, their lumina being occluded by ligation. Under these conditions the segmenting blastocysts drop into the abdominal cavity either to degenerate or to continue development. Development was secured in 2 per cent. of the cases (5 positive in 250). In order to test the capacity of the embryo to develop outside the abdominal cavity one horn of the uterus was delivered through an incision in

¹ From the Nutrition Laboratory of the Carnegie Institution of Washington, Boston, Massachusetts.

the body wall. Its proximal and distal parts were retained within the abdomen, while the uterine horn with its contained 8-day embryos was held in a pocket under the skin by suturing the body wall. Under the conditions of this experiment development proceeds normally, the fetuses are born at term and are viable. Transplantation of eight- and nine-day embryos in locations outside of the abdomen has been performed. The femoral triangle, muscle of the body wall and other locations have been tried. The most favorable site for transplantation thus far secured is the mammary gland. Embryos transplanted to this region undergo disorganized tissue formation. Muscle, both smooth and striated, cartilage, nervous tissue, gut and red blood cells, as well as placental cells, are differentiated and can be distinguished in sections through the graft. The tissues differentiate in their foreign locations in typical form but do not complete the organization of the individual.

The analysis of the factors determining the growth of a population of yeast: OSCAR W. RICHARDS (introduced by L. L. Woodruff). The growth of a population of a pure strain of the yeast *S. cerevisiae* Hansen derived from a single cell is measured for about 1,200 hours. The rate of increase of the population is constant until the waste products (by-products of fermentation) retard the increase by selectively eliminating the buds which have not had time to become resistant after they are independent of the mother cell. The population then reaches an equilibrium number and the first cycle of growth ends. As the sugar is rapidly used less waste products are produced and less cells are killed. The oxygen consumption is greatest then and food material is liberated by the cytolysis of the killed cells. This results in a more favorable medium and the population again increases until further growth is prevented by the accumulation of waste products in the medium and the utilization of the available food. If additional food is added just before the end of the first cycle of growth the growth continues to the same level as would be reached later at the end of the second cycle. The further addition of food does not result in additional growth. After the second growth cycle the structure of the cells changes and most of them gradually become resistant, resting cells. The remainder perish except for a very few hardy cells which continue to reproduce for a long time. The potentially unlimited growth of the cells is restricted and determined by the chemical changes in the medium.

The maturation of the egg of the sea-urchin Mespilia globulus: D. H. TENNENT. In this brief paper one section of a complete study of the history of the chromosomes during the oogenesis of the sea-urchin *Mespilia globulus* that has recently been completed by Dr. Toshio Ito, of the Medical School of Keio University, Tokyo, and myself, will be presented. The sac-like ovaries, at this time, are packed with oocytes, some of which are still in their growth stage. Sections show that the wall of the ovary consists of three layers, a thin outer layer, the coelomic epithelium, a middle layer of muscle fibers

and an irregular inner layer of oocytes, the so-called germinal layer. The oocytes lie in an almost structureless lacunar matrix, within which there are also a few small, apparently amoeboid cells. As the oocytes increase in size some are crowded away from the wall, the number of full-grown oocytes lying in the center of the ovary thus increasing gradually. Two points should be emphasized. There is never any stalk of attachment and there is never a definite cellular egg follicle. All the cells lining the wall in which the nucleus is large or has begun to enlarge are oocytes. Maturation may take place while the oocytes are still in contact with the wall or after they have been forced to the center of the ovary. In only one, out of several hundred examples, have the polar bodies been given off from the surface of the egg adjacent to the wall of the ovary. As a rule, therefore, the animal pole of the egg has developed in the free, rather than in the attached surface. In maturing eggs lying in the lumen of the ovary there is never common orientation of the spindle with respect to a selected region. Prior to the onset of the growth stage in the oocyte the chromosomes disappear after reaching a diplotene stage. At the onset of the meiotic divisions they reappear as diplotene chromosomes in the nucleus of the fully grown oocyte. They become arranged on a typical amphiastral first polar spindle and during early anaphase stretch out as V's and rods. While the chromosomes are separating during the later anaphases and while the spindle system is moving toward the periphery of the egg, the outer aster becomes flattened, the outer end of the spindle finally becoming anastral. The surface of the egg above this blunt end is pushed out as a bud, into which the anastral end of the spindle and the outer chromosomal plate moves. On the equator of the spindle, in fixed and stained preparations, a belt of deeply stained granules constituting a "between body" may be seen. In slightly later stages these granules may be seen in the form of a complete ring surrounding the spindle, the ring seeming to constrict around the spindle, until, when separation is completed, it lies as a large granule or disc on the surface of the egg just below the separated polar body.

The chromosomes left in the egg become arranged on the second polar spindle, which is also at first amphiastral and whose outer end later becomes anastral as it moves out into the second polar body. Here again the phenomenon of a "between body," in the form of a ring that seems to constrict around the spindle, is evident. The second polar spindle and the "between body" interrupt the continuity of the thin jelly layer surrounding the egg that becomes evident about this time. This break in the continuity of the jelly layer explains the origin of the micropyle or funnel at the animal pole of the egg. It has been possible to observe the form and number of the chromosomes in this egg during both maturation divisions. The observations made on this material have made it clear that development from primordial germ cell to oocyte does not take place in the "germinal layer," they have afforded a satisfactory description of the number and form of the

maturation chromosomes, they have shown the manner of origin of the micropyle, and they have confirmed the conclusion reached by Jenkinson in 1911, to the effect that the animal pole of the sea-urchin egg is not at the attached, but at the free end of the egg.

Feather structure in the Phasianidae: STANLEY BALL (introduced by L. L. Woodruff).

Cancer and tuberculosis, with some comments on cancer and other diseases: EDWIN B. WILSON and HELEN C. MAHER.

Measures of certain human abilities throughout the life-span: WALTER R. MILES (introduced by Raymond Dodge). This investigation, conducted in the department of psychology at Stanford University, reports measurements on 335 boys and men and 528 women and girls. The age range was from 6 to 95 years. Effort was made to secure approximately equal numbers of people within the successive semi-decades. At first adults 50 years of age and older were studied. Later, the younger years were added for comparison. The study was conducted in two small cities by the establishment of laboratory annexes easy of access to the people who were to be examined. These individuals were solicited and sent by many different lodges, clubs, churches and other organizations of these cities. The clubs (not the individuals) were paid for this service in terms of the ages of those subjects supplied. The measurements were psychological (not medical or physical) and occupied a period of two hours broken up into half-hour sessions, with suitable rest intervals in between. The ability to organize and carry out simple movements with the hands was studied. There was practically no difference between males and females. In general, the performance of the dominant (right) hand was about 12 per cent. superior to that of the subordinate (left) hand. The maximum ability appeared in the age range 16 to 29, while ages 12 to 13 and 55 to 59 were each 14 per cent. slower. Ages 10 to 11 and 60 to 64 gave equal scores, both 18 per cent. below maximum group ability; 8 to 9, 25 per cent. below; 70 to 74, 33 per cent. and 85 to 89, 50 per cent. decrement.

Ability to respond to outside auditory signals with hand and foot were studied. Simple response of this character is very slightly faster for the hand than for the foot. On the average for adults 25 years old or older, the (unpracticed) time required is very close to one quarter of a second. The peak or standard ability in this function is maintained from age 18 to 55, where it averages close to one fifth of a second. Adults 75 to 90 average close to one third second, but approximately 20 per cent. of these older adults are as fast as the average for groups ranging from 25 to 90 years. Most of the abilities studied show an increase during the early years, a fairly long crest representative of maturity, and a regular decline rather than a sharp change. In the age period 75 to 85 the decrement scarcely ever exceeds one quarter to one third of the score value rep-

resented at group maximum. Decline appears to proceed regularly and slowly and the average old person can still perform as well as many of those who are in middle age, indicating that chronological age is by no means the sole factor accounting for performance ability. The investigation is being continued.

Experiments on the development and growth of limbs in the Amphibia: ROSS G. HARRISON. The vertebrate limb develops as a thickening of the mesoderm of the body wall, covered by epithelium (ectoderm), which is part of the general integument of the body. This thickening with its covering in the embryo is known as the limb bud. In the salamander, *Amblystoma*, the limb bud, while not sharply bounded like a stone in a mosaic, is nevertheless fairly definitely localized in the body wall ventral to the third, fourth, fifth and part of the sixth muscle segments. This system lends itself readily to a great variety of extirpation and transplantation experiments, which are the basis of the present investigation. The respective rôles of the two layers, ectoderm and mesoderm, in the development of the limb have been tested by grafting each separately to other parts of the embryo, by replacing each separately by corresponding tissue from other regions, by changing the orientation of one layer by itself and by combining tissues of two different species. Growth and pigmentation of grafted limbs have been studied in twenty interspecific combinations (between five species) in which the whole limb bud was transplanted. For the embryo from the stage with closing neural folds to the stages with tail bud, the evidence is overwhelming that the capacity to form a limb is inherent in the mesoderm—particularly that of the region described above—and that the ectoderm is not specifically differentiated. Grafting of trunk ectoderm to the limb region is followed by the normal development of the limb, while the reciprocal operations of limb ectoderm to other parts of the body never result in the development of a limb at the seat of the graft. Mesoderm of the flank put in place of mesoderm of the limb bud is followed by suppression of the limb, while mesoderm of the limb region grafted to the flank or, under certain conditions, to the head develops into a well-formed appendage. In contrast to ectoderm from the trunk, ectoderm from any part of the head, taken from embryos after closure of the neural folds, and made to replace limb ectoderm, suppresses the development of the free appendage, while permitting the development of the shoulder girdle. However, if the same ectoderm of the head, particularly of the gill region, is grafted in the same way just before closure of the neural folds the limb bud covered by it develops normally. When the whole limb bud is rotated 180° about the transverse axis of the embryo its laterality is reversed and frequently it is more or less completely reduplicated. If the mesoderm alone is rotated the result is essentially the same, but if the ectoderm alone is rotated normal development usually follows. However, in about 17 per cent. of the cases (9 out of 53) some tendency to reduplication is shown, which is not sur-

prising, since the ectoderm is known to be polarized in other respects and the combination is therefore disharmonic. In interspecific grafts of whole limb buds it is known that the graft grows at its specific rate, and in certain combinations with very different growth rates, limbs that are entirely out of scale with the body (either too large or too small) are produced. In fact, unless the animals are given maximal feeding, the grafted limb may even exceed both the host and the donor control limbs in growth. Similar results, though with perhaps slightly less quantitative differences, are obtained when mesoderm alone is grafted, but when ectoderm alone is grafted the effect on the growth of the limb is very slight. These results have not been subjected to all the requisite statistical tests. In any case, whether the effect of the ectoderm on growth of the limb is significant or not, the quality of the mesoderm certainly dominates the growth rate. The form of the resulting limb is very nearly if not precisely that of the species furnishing the mesoderm. This comes out strikingly both in appendages growing in their normal position and in those growing on the flank or on the head. The amount of webbing of the digits, which differs among the species used, may, however, be slightly influenced by the ectoderm. Even the reduplicating limbs that often arise from grafts placed on the flank have the specific character of the species from which the mesodermal graft was taken, and in only one or two doubtful cases resembled the limbs of the host species. Such limbs are therefore not produced from host tissues by induction. Induced limbs have been found in a few cases after grafting the nasal placode to the flank, as found by Balinsky and others after grafting various organ rudiments or even foreign bodies. In one case we obtained the remarkable paradox that one nasal pit grafted over the limb region suppressed the development of the normal limb, while the other nasal pit grafted to the flank produced by induction a limb where it would not normally have developed. The pigmentation of grafted limbs in normal location is approximately that of the host species except in combinations in which albinotic individuals (axolotl) take part. A grafted limb from a white embryo does not acquire pigment when placed upon a pigmented host and a graft from a pigmented embryo remains pigmented on a white host, as shown by Ruud (also by Schaxel for regenerative buds). These results are interpreted to mean that the pigmented individuals of the five species used have essentially similar pigmentary equipment, and that their coloration, even to a great extent the pattern, is determined by the internal medium of the organism. Only in the case of the white individuals, which lack pigment largely though not entirely, is there inability to respond to the internal conditions.

Differentiation of reflex and voluntary responses of the lid: HELEN PEAK (introduced by Raymond Dodge). The experimental facts regarding the distinction between reflex and voluntary reactions are incomplete and further investigation of the problem is needed in view of the interest in determining whether "conditioned" behavior

is of reflex or voluntary origin. Lid responses dependent on instructions to wink voluntarily are of longer average latency than responses which are relatively independent of such instructions. Longer latency is, therefore, a distinguishing characteristic of voluntary response within certain limits. The present paper reports the investigation of certain other characteristics of these long and short latency responses, such as extent of closure, velocity and duration of closing and opening phases of the lid response. Five thousand photographic records of the lid movements of six subjects, reacting under four sets of instructions to auditory stimulation, show the following results: (1) The extent of closure in the long latency reaction is greater on the average than that of the reflex. (2) In the reflex response the promptness of opening the lid after closure increases with increase in the velocity of closure, *i.e.*, the faster the lid closes, the more promptly it opens. This suggests the operation of a mechanism akin to Sherrington's stretch reflex. (3) In the voluntary response the relationship, though not consistent, tends to be in the opposite direction, *i.e.*, the faster the closure, the slower the opening. (4) The voluntary response is distinguished by a greater delay in the opening phase of response with the following exceptions: (a) When negative adaptation has caused the closing velocity of the reflex to fall below a certain minimum, the opening duration is increased and becomes greater than that of the voluntary (subjects were unable to increase the duration of opening in reflex by deliberate effort); (b) when a subject was instructed to increase the promptness of opening in his voluntary responses, he was able to do so, but *only after practice*. (5) This evidence indicates that when responses are measured in terms of any of these characteristics, "reflex" and "voluntary" are not distinct categories but only convenient terms for distinguishing modes in continuous distributions of response.

The cats of Rancho La Brea; a climax in evolution: JOHN C. MERRIAM. The asphalt deposits of Rancho La Brea near Los Angeles have furnished a unique collection of fossil remains from the geological period immediately preceding the present. The collection consists of unmodified skeletons representing a wide variety of animals. It gives a picture of the life in this region at the time these deposits were forming. So far as known it is the largest body of material representing the life of this period that has been obtained from a single locality. The collection is also unique in that it contains a larger percentage of carnivorous animals than would be found in any normally balanced fauna. The cats of Rancho La Brea include numerous individuals from both the saber-tooth and true cat groups. At least six species are represented. They include two species of *Smilodon*, one lion-like cat recognized as *Felis atrox*, two pumas, both new species, and one smaller cat practically identical with *Lynx rufus* of the living California fauna. The large size and high stage of development of species in both groups mark a climax in evolution of this carnivore family. The paper presents results from an extended study involving several persons and institutions.

A preliminary report on functional psychoses: H. BECKETT LANG and J. A. PATERSON (introduced by W. D. Bancroft). Experiments with forty-six patients suffering from functional psychoses have shown a correlation between the type of insanity and the state of dispersion of the brain proteins. Schizophrenia is an over-dispersed type. Manic-depressive and epileptic patients are in a coagulated state. Sodium amytal and sodium rhodanate are helpful for diagnostic purposes. These will not displace known and applicable methods of therapy but may supplement them.

The physiological properties of bulbocapnin: WILDER D. BANCROFT. Bulbocapnin produces in cats a catalepsy which has been identified by Dr. Walter Freeman and others as corresponding to dementia praecox catatonica in man. If this were so, bulbocapnin should be a peptizing agent for proteins. Actually, it is a coagulating agent and brings a man out temporarily from the ordinary catatonic stupor. Sodium rhodanate and ephedrine counteract the action of bulbocapnin on rabbits. The bulbocapnin stupor in cats corresponds to what Dr. Lang calls benign stupor in man. This last is a coagulated state.

*Induction of the ear by the medulla and its relation to experiments on the lateralis system in Amphibia:*¹ L. S. STONE (introduced by R. G. Harrison). In the development of amphibians the ear and the lateral-line first appear as an acustico-lateralis placode in the ectoderm near the medulla of the primitive brain tube. The lateralis system soon separates from that of the ear as pre- and post-auditory placodes, parts of which give rise to ganglia and parts to migratory primordia that lay down lateral-line sense organs. This system when vitally stained is ideal for studies upon the phenomena of polarity and growth direction and what relation the establishment of these has to structures in its environment. For example, in the postauditory placode the anterior ganglionic pole near the ear and the opposite or posterior migrating pole are determined soon after the closure of the neural folds. This occurs before ear-forming cells can be completely isolated experimentally from it and at a period subsequent to that in which Dr. R. G. Harrison found the establishment of the polarity of the ear. In the early tail-bud stage the ear and the ganglionic pole of the lateralis placode can be excised without effect upon the migration of the opposite pole and the formation of lateral-line sense organs. If, however, a polarized or non-polarized placode is grafted to a new position upon the side of the body the ganglionic pole will differentiate, but the migratory pole lies dormant and is unable to organize itself into sense organ forming tissue unless a migrating primordium of the host eventually touches it. Then the growth direction of that of the graft is dominated by the host primordium. If, furthermore, one includes a portion of the medulla along with a polarized acustico-lateralis placode and places the

graft upon the side of the body the lateralis placode goes a step further in the formation of a few sense organs, but still it does not migrate in the presence of well-formed brain tissue. The presence of the latter may have some connection directly or indirectly with the degree of development of the primordium to the point of sense organ formation. It can not be said that strange ectoderm prevented the initiation of migration, for control experiments have shown otherwise. The ear on the other hand was not normal. This may indicate that the lateralis itself could not be expected to be fully developed in all respects. At the moment migration is normally initiated a disconnection from the associated ganglion and the brain by transplanting the primordium to the side of the body far from its normal environment does not interfere with its ability to proceed in migration and to lay down lateral-line sense organs in the direction toward which its pole is oriented. Its growth direction may be entirely changed, however, if in its grafted position it lies so that a similar migrating primordium of the host touches it. Its growth direction is then dominated by that of the host primordium. Its power to reach the point when the migratory ability is initiated must therefore in part depend upon a phase in development during a stage when it is closely associated with the ear and the medulla. It was found to be practically impossible to eliminate all the ear-forming cells from the earliest stages in the ectoderm before the acustico-lateralis was even recognizable as a placode without eliminating the lateralis also. It was desirable then to discover what influence the medulla was normally exerting upon the ectoderm lateral to it. Therefore, the medulla-forming portion of the neural plate was transplanted to the side of the body and placed in such a manner that the lateral edge of the medulla touched the overlying body ectoderm. An incomplete ear with its ganglion was induced, but no lateralis placode. Since the center of the acustico-lateralis placode, *viz.*, the ear, was so feebly developed out of the indifferent body ectoderm it may indicate that the graft was taken at a time in its development when its inductive power was limited only to a selective part of the system, or that the ectoderm itself resisted the full influence of the medulla. It may indicate furthermore that the medulla has induced only the dominant part of the system and that if a well-developed ear could have been formed it in turn might have been able to induce secondarily the lateralis portion. Whatever the case may be it at least emphasizes the necessity of a new conception concerning the early development of these two interrelated systems in order to understand more fully the methods by which the polarity and subsequent migration of the lateralis is accomplished.

Discovery of Upper Eocene land mammals on the Pacific Coast: CHESTER STOCK (introduced by J. C. Merriam). In the stratigraphic column of the Coast Ranges of California the Sespe formation occupies a position between marine deposits of Eocene age and marine deposits of Lower Miocene age. North of the Simi Valley in Ventura County the Sespe is 7,470 feet

¹ From the Department of Anatomy, Yale University School of Medicine.

in thickness, rests with disconformable contact on the Domengine horizon of the Eocene and is conformable with the overlying Vaqueros marine beds of Lower Miocene age. Greenish and maroon shales and sandstones which are particularly characteristic of a conveniently recognizable middle division of the Sespe in the Simi anticline have yielded vertebrate remains. Occurrences of fossil mammals range vertically in the section from approximately 1,600 feet to 3,000 feet above the contact with the Eocene. The fauna includes *Paramys*, a creodont, insectivores, bunoselenodont artiodactyls, an agriochoerid, *Epitriplopus* (?), an amynodont and titanotheres. Some of the more important features of the discovery of this assemblage are: (1) The earliest Tertiary record of land mammals thus far known on the Pacific Coast; (2) the occurrence offers opportunity to establish on the basis of vertebrate paleontology the time relationships of the early Tertiary portion of the stratigraphic column of the Coast Ranges to the continental sequence as determined in the Rocky Mountains and western Great Plains; (3) several mammalian types in the fauna are structurally more advanced than related forms of the Upper Uinta Eocene and are evidently more primitive than forms known from the White River Oligocene; (4) added information is available concerning the geographic distribution of some early Tertiary mammals in North America.

Observations on individual growth: FRANZ BOAS.

The significance and inheritance of leg-length in dogs: CHARLES R. STOCKARD.

Conceptual categories in primitive languages: EDWARD SAPIR (introduced by C. Wissler). The relation between language and experience is often misunderstood. Language is not merely a more or less systematic inventory of the various items of experience which seem relevant to the individual, as is so often naïvely assumed, but is also a self-contained, creative symbolic organization, which not only refers to experience largely acquired without its help but actually defines experience for us by reason of its formal completeness and because of our unconscious projection of its implicit expectations into the field of experience. In this respect language is very much like a mathematical system, which, also, records experience, in the true sense of the word, only in its crudest beginnings but, as time goes on, becomes elaborated into a self-contained conceptual system which previsions all possible experience in accordance with certain accepted formal limitations. Such categories as number, gender, case, tense, mode, voice, "aspect" and a host of others, many of which are not recognized systematically in our Indo-European languages, are, of course, derivative of experience at last analysis, but, once abstracted from experience, they are systematically elaborated in language and are not so much discovered in experience as imposed upon it because of the tyrannical hold that linguistic form has upon our orientation in the world. Inasmuch as languages differ very widely in their systematization of fundamental concepts, they tend to be only loosely equivalent to each other as symbolic devices

and are, as a matter of fact, incommensurable in the sense in which two systems of points in a plane are, on the whole, incommensurable to each other if they are plotted out with reference to differing systems of coordinates. The point of view urged in this paper becomes entirely clear only when one compares languages of extremely different structures, as in the case of our Indo-European languages, native American Indian languages and native languages of Africa.

The genesis of cerebellar tremor and its disappearance after removal of the cerebral hemispheres: J. F. FULTON (introduced by Yandell Henderson). One of the most striking locomotor disturbances encountered in the field of clinical neurology is the tremor associated with lesions of the cerebellum. Though recognized as the essential symptom of cerebellar deficit as early as 1824 (Flourens), its nature has remained obscure. We have therefore focused our attention upon the genesis of tremor following removal of the cerebellum (cats, dogs, monkeys and baboons) and have found that in the cat it does not appear until the fourth to the seventh day after the operation. Simultaneously with the appearance of the tremor, the animal commences to execute voluntary movements. In other animals in which tremor appears sooner, it is always coincident with the return of voluntary activity. Since the cerebellum had been removed the question arose as to what part of the nervous system was responsible for the tremor. On removal of one cerebral hemisphere in the decerebellated animal the extremities of the opposite side become rigid but continue to show associated movements unaccompanied by tremor. When the second cerebral hemisphere is removed, thus making a decerebellated thalamic preparation, great locomotor activity is seen in all extremities, but tremor is completely absent. We have thus far succeeded in keeping preparations of this character under observation for periods varying from one to three weeks. Further observations are being made on primates, in which the relation of the neocerebellum to the motor cortex is being studied. We conclude that cerebellar tremor is a phenomenon resulting from inadequate compensatory action of the cerebral hemispheres.

The rate of trophic impulses in nerves of cold-blooded vertebrates: G. H. PARKER and V. L. PAINE. The lateral-line nerve of the catfish transmits sensory impulses in one direction and trophic impulses in the opposite. The rate of transmission of the trophic impulses is very slow, approximately two centimeters per day.

(To be continued)

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